A STUDY TO IDENTIFY VARIABLES WHICH PREDICT ELEMENTARY SCHOOL PRODUCTIVITY

By

CARL J. DAEUFER

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A STUDY TO IDENTIFY VARIABLES WHICH PREDICT ELEMENTARY SCHOOL PRODUCTIVITY

By
Carl J. Daeufer
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Chairman: Dr. Kern Alexander, Jr.
Major Department: Educational Administration

The primary problem of this study was to identify school and nonschool variables which would differentiate high and low productivity in urban elementary school centers. The problem was investigated in two phases. Phase one used simple regression analysis to identify a dichotomous criterion of elementary school productivity through the measured relationship of pupil achievement and per pupil expenditures. Sixty-eight elementary school centers which served grades one through six and administered the 1969-1970 district-wide fourth grade achievement tests constituted the sample in phase one. Phase two employed stepwise discriminant analysis to find a discriminating function for each of several combinations of input variables that would predict high or low productivity. The criterion variable was the identified 30 high and low productive elementary school centers, and the independent predictor variables used in phase two represented a composite of 25 school and nonschool input measures and five combinations organized into problem sets for analysis. These included (1) one problem set which used student related variables, (2) two problem sets, one which focused on school while the other on all nonschool related variables;

and (3) two problem sets categorized into administrative decision making and non-decision making related variables.

Independent variable data were obtained from urban district records for school year 1968-1969, and income data were obtained from a merger of 1968-1969 U. S. Office of Education records and the Internal Revenue records of 1966.

In predicting high or low productivity, the discriminant analyses produced discriminating equations which classified the identified elementary school centers into one of the two productivity groups. Within each set of equations a maximal mix of predictor variables was observed. The efficacy of these prediction equations was tested by calculating both the percent of accurately classified elementary school centers and the efficiency of discrimination, or amount of variance explained by the variables included in the discriminant function of each problem set.

The major findings and conclusions were:

1. High and low productive elementary school centers are ascertainable when using simple regression analysis to measure the relationship of achievement to expenditure.

2. In the composite and administrative decision making problem sets student socioeconomic and teacher preparation predictors tended to be the maximal discriminating variables of productivity. The findings suggest that varying percentages of pupils from low income families and certificated staff without a degree may explain most of the variance between elementary school center productivity groups.

3. In the school related problem set staff sociocultural characteristics and teacher preparation and experience tended to be the maximal discriminating

variables of school productivity. The results suggest that varying percentages of nonwhite professional staff, certificated staff without a degree and differences in years of teaching experience may account for most of the variance in school productivity.

4. In the administrative nondecision making problem set predictors relating to pupil attendance and the income level of residents of a geographical area served by a school center tended to be the maximal discriminating variables. The findings suggest that different levels of average daily attendance by students and varying percentages of income above $10,000 may explain most of the variance in elementary school center productivity.

5. The input-output analytical procedures employed in this study were generally definitive in identifying input variables predictive of high and low productivity. The findings suggest that the discriminant functions derived in these six problem sets accurately predicted high or low productivity 90 to 100 percent of the time and accounted for 86 to 100 percent of the variance between the productivity groups.

CHAPTER I
INTRODUCTION

At no time in the history of our country has public education been subjected to such intensive scrutiny as today. Among the current educational concerns is improving the quality of public schools in the large cities of the nation. It is within the metropolitan areas, specifically the inner cities, that many of the culturally different groups are concentrated. Partly because of this concentration, the large cities of the nation are confronted with complex educational, political, and fiscal problems.

Increased school costs, stiffened taxpayer resistance,[1] agitation for "quality education," and needed change in the political processes[2] by which urban schools make decisions are among the major factors which contribute to the intensified concerns regarding urban education.

Concerns about education in urban areas have been related to outputs as well as inputs. An underlying concept associated with these concerns is the concept of

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[1] James M. Buchanan, "Taxpayer Constraints on Financing Education," Economic Factors Affecting the Financing of Education, Vol. 2 (Gainesville, Florida: National Educational Finance Project), 1970, pp. 277-280.

[2] Henry M. Levin, "The Effect of Different Levels of Expenditures on Educational Outputs," Economic Factors Affecting the Financing of Education, Vol. 2 (Gainesville, Florida: National Educational Finance Project, 1970), pp. 199-200.

productivity. More specifically, urban educational concerns have not been restricted to investment factors such as increased cost and bond issues but also to educational performance. For example, the central task inherent in the relationship between the human and material resources which education consumes (inputs) and educational performance (outputs) has been one of identifying variables which contribute to greater return from educational dollars.

Previous empirical studies, which applied input-output analysis techniques to search for various school and nonschool correlates to school performance, have been limited by difficulties associated with (1) measuring and defining school and nonschool variables (inputs), and (2) defining school performance (outputs).[3] However, these difficulties are not insurmountable. Quade noted that:

> The key to successful analysis is a continuous cycle of formulating the problem, selecting objectives, designing alternatives, collecting data, building models, weighting cost against performance, testing for sensitivity, questioning assumptions and data, re-examining the objectives, opening new alternatives, building better models, and so on, until satisfaction is obtained or time or money force a cutoff.[4]

The interest in the present study was to employ appropriate analyses which would generate additional knowledge associated with inputs to school performance so as to enable the urban elementary school administrator to create and operate a more productive school. What, then constitutes a high and a low productive elementary school center? Which input variables, either singly or in combination, contribute

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[3] Thomas P. Wilbur, Research into the Correlates of School Performance: A Review and Summary of Literature, Assessment Report No. 3. (Lansing, Michigan: Michigan Department of Education, 1970), pp. 11-14.

[4] E. S. Quade, Systems Analysis Techniques for Planning-Programming-Budgeting, P-3322 (Santa Monica, California: The RAND Corporation, March, 1966), pp. 10-11.

to the prediction of high and low productivity? These questions are the major focuses of this investigation.

The Problem

Statement of the Problem

The primary problem of this study was to identify those school and nonschool variables which would differentiate high and low productivity in selected elementary school centers located in a selected urban school district. In accomplishing this purpose, the specific aims of this study were:

1. To identify high and low productive elementary school centers through the measurement of the relationship between current expenditures per pupil and median composite standardized achievement test scores of fourth grade pupils.

2. To determine a single variable or a combination of variables that would predict high and low productivity.

Delimitations

The delimitations of this study were grouped in two phases: (1) those related to the identification of high and low productive elementary school centers, and (2) those related to the determination of variables. In phase one, the following were the delimitations of this study:

1. It was confined to an investigation of elementary school centers which served grades one through six, and were located in an urban school district, and had administered the district-wide standardized achievement tests to fourth grade pupils during the 1969-1970 school year.

2. The current expenditure data used in this study were based upon those

expenditures for the school year 1968-1969.

In phase two, the following were delimitations of this study:

1. It was confined to an investigation of elementary school centers in an urban school district which were identified as having high or low productivity.

2. It was further confined to those school and nonschool variables which were available for comparison among the selected elementary school centers having high or low productivity.

3. The data concerning these variables were further delimited as to their availability during the span of school years, 1966-1967 through 1969-1970.

Limitations

This investigation was an exploratory field study and was, therefore, subject to certain weaknesses inherent in its ex post facto design. These major weaknesses included: (1) the problems associated with the precise measurement of the variables, (2) the use of a large number of variables, and (3) the inappropriateness of generalizing beyond the elementary school centers used in the study.[5]

An additional limitation lay in a precondition set for conducting this study; and that was that the name of the selected urban school district be withheld. Thus, conclusions of the study which were of a revelatory nature were necessarily affected.

Justifications for the Study

A current and major educational problem concerns the capacity of an educational

[5] Fred N. Kerlinger, Foundations of Behavioral Research (New York: Holt, Rinehart and Winston, Inc., 1964), pp. 388-391.

system to raise achievement levels of low income and culturally different students, and to accomplish this by effectively allocating scarce resources.[6] These notions of raising achievement levels and allocating resources imply a relationship. The logic of this relationship has been receiving considerable research attention and effort aimed at developing some important empirical evidence from which effective administrative decision making could result. Specifically, this study was designed to offer an alternative method for measuring this relationship.

To date, research findings have not been fully adequate to provide the basis for decision models. This investigation was a part of a programmatic package of research conducted under the National Educational Finance Project (NEFP) at the University of Florida. It was designed to contribute partially to efforts to conceptualize various models of school finance and then to subject them to consequential analysis to identify the strengths and weaknesses of each model.[7] Further, empirical evidence gathered in a research project such as this study provides additional information necessary for the development of exemplary financial models for public schools.[8]

Research literature has revealed a continued need for input-output studies which could contribute to improved effectiveness in administrative decision making and to

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[6] Jerolyn R. Lyle, Research on Achievement Determinants in Educational Systems: A Survey (Washington, D. C.: USOE, DHEW, National Center for Educational Statistics, Division of Operational Analysis, 1968), pp. 1-3.

[7] Roe L. Johns, Kern Alexander, and Richard A. Rossmiller (eds), Dimensions of Educational Need, Vol. 1 (Gainesville, Florida: National Educational Finance Project, 1969), p. 227.

[8] Selma Mushkin and James R. Cleaveland, "Planning for Educational Development in a Planning, Programming, Budgeting System," Interdependence in School Finance: The City, the State, the Nation (Washington, D. C.: National Education Association, 1968), p. 60.

increased efficiency in the operation of schools. Sexton[9] and Burkhead[10] indicated that variation among schools within districts may be as great or greater than that between school districts.

This study focused on elementary school centers in a Midwestern urban school district. Its input-output design was somewhat unique in that, following the identification of high and low productive elementary schools, the study was designed to determine those school and nonschool variables which would contribute to the prediction of high and low productivity.

Assumptions

There were four basic assumptions fundamental to this study. They included:

1. Education output, as one measure of pupil performance in an elementary school center, was reflected in the median composite standardized achievement test scores of pupils in that elementary school center.

2. The measured relationship between per pupil expenditure and a measure of pupil achievement was an indicator of productivity.

3. When identifying elementary school centers of similar per pupil expenditure (input), the variation of pupil achievement (output) which occurred in these elementary school centers was attributed to something other than chance.

4. The information available in central office reports, state regional reports, and census bureau reports was reliable and accurate.

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[9] Patricia Cayo Sexton, Education and Income: Inequalities in Our Public Schools (New York: Viking Press, 1964), Chapter 2.

[10] Jesse Burkhead, Thomas G. Fox, and John W. Holland, Input and Output in Large-City High Schools (Syracuse: Syracuse University Press, 1966), pp. 56-59.

Definition of Terms

Achievement test. -- A measure of proficiency level gained by testing the performance actually displayed in the Iowa Tests of Basic Skills, Grades 3-9 Form 4.

Average daily membership (ADM). -- The aggregate days membership of a given elementary school during the 1968-1969 school year divided by the number of school days in that year.

Average productivity. -- A line of regression established by relating median composite achievement test score to per pupil current expenditure of elementary school centers. Thus, for purposes of this study, average productivity represented the ratio of the predicted value of median elementary school center achievement to a given level of per pupil current expenditure.

Current expenditure. -- Total expenditures for administration, instruction, auxiliary services, operation of plant, maintenance of plant, and fixed charges together with net expenditure for food services and study body activities for the 1968-1969 school year. This encompasses all expenditures except those for capital outlay, community services, and debt service.

Current expenditure, per pupil. -- Current expenditures for the 1968-1969 school year divided by average daily membership (ADM).

Dependent or criterion variable. -- A variable which is predicted, and which is the ultimate subject of a research study. The dependent variables in this study were the median elementary school center composite achievement test score and the identified high and low productive elementary school centers.

Discriminant analysis. -- A multivariate statistical procedure used to find a

linear function of one or more variables that best separates classes or groups.

Elementary school center. -- An elementary school in an urban school district which administered the district-wide standardized achievement tests to fourth grade pupils during the 1968-1969 school year.

F-to-enter. -- The F test of significance of a single variable in a stepwise discriminant equation when the question under consideration is the value of adding that variable to the equation.

F-to-remove. -- The F test of significance of a single variable in a stepwise discriminant equation when the question under consideration is the value of deleting that variable from the equation.

High productivity. -- Achievement that lies at or some level above the average productivity. In this study, three-fourths of the estimate of error in predicting a median composite achievement score from a given level of per pupil expenditure represented that level.

Independent variable. -- A variable from which prediction is made. The independent variables in this study were the elementary school center per pupil current expenditure, and the various combinations of school and nonschool variables used to predict high and low productive elementary school centers.

Low productivity. -- Achievement that lies at or some level below the average productivity. In this study, three-fourths of the estimate of error in predicting a median composite achievement score from a given level of per pupil expenditure represented that level.

Pupil-unit of measure. -- A standard measurement having a pupil related factor as its unit.

Standard Metropolitan Statistical Area. -- The Census Bureau classification which includes cities of 50,000 population or more and the surrounding urban fringe under the influence of a central city.

Urban school district. -- A quasi-corporation, authorized or established by the state for local organization and administration of schools, and classified by the Census Bureau's Standard Metropolitan Statistical Area as being urban.

Procedures

This study was designed to identify those school and nonschool variables which would differentiate high and low productivity in selected elementary school centers in an urban school district. The procedures that were employed in this study are discussed in this section. The section is divided into three major parts. They include: (1) Study Design, (2) Identification of High and Low Productive Elementary School Centers, and (3) Identification and Treatment of Variables Associated with High and Low Productive Elementary School Centers.

Study Design

This ex post facto study was organized into two phases.[11] Phase one used simple regression analysis to identify high and low productive elementary school centers in an urban school district by measuring the relationship between per pupil current expenditures and median composite achievement test scores. Phase two of the study employed discriminant analysis to find a function for each of several various measurements of school and nonschool (independent) variables that predicted elementary school center productivity as measured by the criterion (dependent)

[11] Kerlinger, pp. 359-391.

variable developed and defined in phase one.

Identification of High and Low Productive Elementary School Centers

All elementary school centers in the urban school district which served pupils in grades one through six and administered district-wide achievement tests to fourth grade pupils during the 1969-1970 school constituted the sample in phase one of this study. A total of 68 elementary school centers met this condition.

A regression line was developed. For each elementary school center in the sample, the fourth grade pupils' median composite standardized test score was used as the dependent variable and the per pupil current expenditure for each elementary school center for the school year 1968-1969 was used as the independent variable.

The per pupil current expenditure data for each elementary school center were compiled from the centrally located urban school district's records. Capital outlay and debt service expenditures were not included. The achievement test data used for each elementary school center were derived from the results of the Iowa Tests of Basic Skills, Grades 3-9, Form 4, administered in October, 1969. These data were also obtained from centrally located district records.

The purpose of the regression line was to predict average productivity; that is, the ratio of the predicted value of elementary school center achievement to a given level of per pupil expenditure.

Two groups of elementary school centers were identified in the urban school district: (1) high productive elementary school centers were located at or some level above the regression line, and (2) low productive elementary school centers were located at or some level below the regression line. In this study, three-fourths of a standard error of estimate represented that level.

On the basis of this dichotomous criterion, 15 high productive elementary school centers (H) and 15 low productive elementary school centers (L) constituted group membership in phase two of this study.

Identification and Treatment of Variables Associated with High and Low Productive Elementary School Centers

This section is divided into a discussion of (1) the selection and data sources of the independent variables (inputs) used in phase two of this study, and (2) the statistical treatment utilized to compute linear functions for the urban school district.

Selection and sources of independent variables

Measurements were made of the independent variables (inputs) which were descriptive of both the school and nonschool community factors associated with every identified elementary school center. The variables selected for use in the second phase of this investigation represented those independent (input) variables which were common to both the high productive and the low productive elementary school center groups.

The following criteria guided the selection of the independent (input) variables employed in phase two:

1. Variables used previously by researchers to examine correlates to school performance.
2. Variables selected by the research staff of the National Educational Finance Project (NEFP) which were postulated as being related to elementary performance.

3. Variables selected from available data which were recorded centrally in the urban school district studied during the span of school years, 1966-1967 through 1969-1970.

Twenty-five independent (input) variables met the selection criteria stated above. Of these, 20 variables which were descriptive of school and nonschool characteristics including student and community characteristics were compiled from available data. The sources of the data were the urban school district's Division of Research, Statistics and Information; Division of Staff Personnel; Division of Educational Opportunity Services; Division of Psychological Services; and the Division of Program Research and Design. Other sources for two independent variables of similar description included a three-state regional study for 1966, and the superintendent's statistical report for school year 1968-1969. The data for the three independent variables descriptive of personal income were obtained from a merger of the IRS Master File of Zip Code Area Data[12] and the USOE Master File of the Universe of Public and Non-Public Elementary and Secondary Day Schools, 1968-1969.[13]

Treatment and analysis of data

The studies discussed in the review of literature in Chapter II indicated that most researchers interested in input-output analysis have considered the relationships

[12] U. S. Department of the Treasury, Internal Revenue Service, Individual Master File of Income Tax Returns for 1966 (Washington, D. C.: Internal Revenue Service, 1966), Master file computer print-out.

[13] U. S. Department of Health, Education, and Welfare, National Center for Educational Statistics, Directory-Public Elementary and Secondary Schools 1968-1969 (Washington, D. C.: U. S. Office of Education, 1969), Master file computer print-out.

between several predictors and a single criterion. This study was concerned with the problem of finding several linear functions of one or more variables which predicted into which of two groups, high productivity or low productivity, an elementary school center was likely to enter. This type of prediction involved the use of a statistical procedure called stepwise discriminant analysis.[14] Computer procedures related to this statistical procedure are described in BMD Biomedical Computer Programs.[15]

Thus, in phase two of this study, a discriminant analysis technique was used for the urban school district studied. To predict elementary school center productivity, six discriminant analyses were performed. A composite of 25 school and nonschool independent (input) variables was analyzed, as were five combinations of these variables. The five combinations included (1) one discriminant using student related variables; (2) two discriminants, one of which focused on all the school related variables and the other with all the nonschool related variables; and (3) two discriminants developed by categorizing the 25 school and nonschool variables into either administrative decision making related variables or administrative nondecision making related variables.

Using these combinations of independent (input) variables as predictors and the elementary school center group membership defined in phase one as the dependent

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[14] U. S. Department of Agriculture, Forest Service, Linear Regression Methods for Forest Research (Madison, Wisconsin: U. S. Department of Agriculture, Forest Service, Forest Products Laboratory, December, 1964), p. 94.

[15] W. J. Dixon (ed), BMD Biomedical Computer Programs (Berkeley: University of California Press, 1970), pp. 214a-214t.

or criterion variables, a series of linear functions of one or more variables were computed to examine the differences among the a priori classified groups. In effect, what was sought were several linear combinations of variables that would provide the best discriminating equations to predict high or low productive elementary school centers.

Further information regarding the statistical procedures employed can be found in references such as Cooley and Lohnes, Anderson, or Ezekial and Fox.[16]

Organization of the Remainder of the Study

Chapter II presents a review of the related literature relative to the problem of this study, and discusses the selection of the independent variables employed in the research design. Chapter III presents the basic data concerned with the identification of the high and low productive elementary school centers, the selection of the independent variables used in the discriminant analyses, and the discriminant functions and their respective variables used to predict elementary school center productivity. Chapter IV analyzes the discriminating variables and their relative significance to predict elementary school center productivity. Chapter V is devoted to the summary, conclusions, and recommendations for further study.

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[16] William A. Cooley and Paul R. Lohnes, Multivariate Procedures for the Behavioral Sciences (New York: John Wiley and Sons, Inc., 1962); T. W. Anderson, Introduction to Multivariate Statistical Analysis (New York: John Wiley and Sons, Inc., 1958); Mordecai Ezekial and Karl A. Fox, Methods of Correlation and Regression Analysis (3rd ed.; New York: John Wiley and Sons, Inc., 1959).

CHAPTER II
REVIEW OF RELATED LITERATURE

This chapter discusses selected literature and empirical studies as they pertain to three interrelated areas of this investigation. These areas are sectioned into (1) Educational Measures of Output, (2) School and Nonschool Measures of Input, and (3) Input-Output Paradigm.

The empirical studies included in this review were classified as cross sectional or longitudinal. The former were executed at one point in time, and the latter were involved in a series of time.[1]

The cross sectional studies generally used multiple correlation to estimate the extent to which achievement differentials were attributed to school program differences and personnel inputs. The longitudinal studies usually followed student participation over a period of time to estimate input-output relations.

Numberous difficulties have confronted researchers interested in precisely

[1] Alan G. Hickrod, "Local Demand for Education: A Critique of School Finance and Economic Research CIRCA 1959-1969," Review of Educational Research XLI (February, 1971), p. 35.

specifying school input-output relationships in longitudinal studies.[2, 3, 4] Specifically, the difficulties in isolating the precise nature of interschool differences, as a child progresses through school, have created major problems for them largely because of the interaction and interrelationship of socioeconomic and school environment factors.[5]

This study was categorized as being cross sectional; that is, it was executed at one point in time and dealt with the measured relationship of elementary school achievement and expenditure. The measured results were used to predict elementary school productivity through analyses of various school and nonschool independent variables.

Educational Measures of Output

The outputs of a formal system of public education are varied, many, and changeable over time. One investigator[6] classified outputs into two broad

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[2] Samuel S. Bowles and Henry M. Levin, "The Determinants of Scholastic Achievement -- An Appraisal of Some Recent Evidence," The Journal of Human Resources, III (Winter, 1968), pp. 3-24.

[3] James S. Coleman, Ernest Q. Campbell, Carol Hobson, James McPartland, Alexander M. Mood, Fredric D. Weinfold, and Robert L. York, Equality of Educational Opportunity (Washington, D. C.: U. S. Government Printing Office, 1966), p. 325.

[4] Robert Taylor Greene, An Analysis of the Relationships of Selected Factors to Academic Achievement of Pupils (Ed. D. dissertation, University of Virginia, 1970). Cited in Dissertation Abstracts International, 31 (March, 1971), p. 4416A.

[5] Jerolyn R. Lyle, Research on Achievement Determinants in Educational Systems: A Survey (Washington, D. C.: USOE, DHEW, National Center for Educational Statistics, Division of Operational Analysis, 1968), pp. 1-2.

[6] Jesse Burkhead, Thomas G. Fox, and John W. Holland, Input and Output in Large-City High Schools (Syracuse: Syracuse University Press, 1966), pp. 24-25.

subgroups, "skill improvement" and "socialization." "Skill improvement" included increases in earning capacity, employability, as well as increased intellectual curiosity, development of creativity or improvement in physical health. "Socialization" referred to learning to work in groups, and developing group values and group motivation.

The review of literature suggested three educational measures of output which commanded the attention of the majority of the researchers. These were: (1) standardized achievement tests, (2) student holding power, or student retention until completion of a given level of schooling, and (3) "adaptability" as measured by the system's openness to change. The remaining discussion in this section focuses on these three measures of educational output.

Standardized Achievement Tests

Burkhead,[7] Sexton,[8] Thomas,[9] and Wilbur[10] indicated that the standardized test used to measure student achievement has been the most widely used measure of output. They also stated that it is the best criterion to use in measuring immediate educational outcomes.

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[7] Ibid., p. 25.

[8] Patricia Cayo Sexton, Education and Income: Inequalities in Our Public Schools (New York: Viking Press, 1964), p. 25.

[9] J. Alan Thomas, The Productive School: A Systems Analysis Approach to Educational Administration (New York: John Wiley and Sons, Inc., 1971), pp. 16-17.

[10] Thomas P. Wilbur, Research into the Correlates of School Performance: A Review and Summary of Literature, Assessment Report No. 3. (Lansing, Michigan: Michigan Department of Education, 1970), pp. 1-2.

Sexton[11] stated achievement tests indicate "... how well students are coming up to the academic standards which the schools themselves set." Thomas[12] cited their use in another way, "... these measures do predict with fairly high accuracy both future success in school and the tendency to obtain additional information."

Some limitation in the use of achievement tests were noted by Pierce and Mallory:[13]

> The basic measures of achievement available are existing state and local tests. These have two major limitations in that, first, achievement tests are not available or are generally not used in all areas of the school curriculum. Second, in all areas where achievement tests are available and used, they generally fail to provide any measures for affective learning, a matter of considerable concern in terms of educational objectives.

Many studies, Bragg,[14] Dunnell,[15] Kiesling,[16] Osburn,[17] and Thomas[18] correlated achievement with expenditure.

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[11] Sexton, p. 25.

[12] Thomas, p. 16-17.

[13] Louise Pierce and Richard Mallory, Analysis of Achievement: PROJECT DESIGN. Interagency Planning for Urban Educational Needs, No. 5 (Washington, D. C.: USOE, DHEW, Bureau of Elementary and Secondary Education, 1968), pp. 3-4.

[14] Desmond H. Bragg, A Study of the Size-Cost-Achievement Relationships in the Re-Organized School Districts of Wisconsin (Ph.D. dissertation, The University of North Carolina, 1961).

[15] John Peter Dunnell, Input and Output Analysis of Suburban Elementary School Districts (Ed.D. dissertation, Illinois State University, 1970).

[16] Herbert J. Kiesling, "Measuring a Local Government Service: A Study of School Districts in New York State," Review of Economics and Statistics, XLIX, No. 3 (August, 1967), pp. 356-367.

[17] Morris Osburn, The Effect of Expenditures Per Pupil and Size of School on the Quality of Education in the Secondary Schools in Mississippi (Ed.D. dissertation, University of Southern Mississippi, 1962).

[18] James Alan Thomas, Efficiency in Education: A Study of the Relationship Between Selected Inputs and Mean Test Scores in a Sample of Senior High Schools (Ph.D. dissertation, Stanford University, 1962).

Dunnell[19] explored the relationship between expenditure and achievement, considering assessed valuation and socioeconomic factors; and Kiesling[20] investigated the achievement and expenditure relationship of social class backgrounds, type of school and size of school district. Kiesling's investigation indicated that the effect of additional expenditures on achievement varied according to the initial expenditure level, type of school, and the size of the school district. In his study of 44 suburban elementary school districts, Dunnell[21] found that socioeconomic characteristics were the most highly related factors with achievement at both the fourth and seventh grades.

"Disadvantaged" children were the subject of a longitudinal study conducted by Fishman and his associates.[22] Over a period of time, a decline in academic aptitude and achievement was noted. Fishman attributed this decline to poor self concept and repeated failure in a school system organized along middle class norms and skills. Retardation of these culturally different youngsters took on a cumulative effect as promotion to the next grade occurred, regardless of deficiencies in essential skills, especially those which were verbal or symbolic in nature.[23]

An investigation by LaVigne[24] in 1970 correlated intelligence test scores with

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[19] Dunnell, p. 1532-A.

[20] Kiesling, pp. 256-267.

[21] Dunnell, p. 1532-A.

[22] Joshua M. Fishman, M. Deutsch, L. Kogan, R. North, and M. Whiteman, "Guidelines for Testing Minority Group Children," Education of the Disadvantaged (New York: Holt, Rinehart, and Winston, Inc., 1967), p. 162.

[23] Ibid., p. 162.

[24] John Anthony LaVigne, Differences Between Predicted and Actual Achievement Test Scores as an Output Criterion of Secondary Schools (Ed.D. dissertation, New York: Columbia University, 1970).

achievement subtest scores at the secondary level, and used the residual scores between achievement and predicted achievement to study socioeconomic and school factors. Reported results showed that the socioeconomic status variables produced significant correlation coefficients. In some instances, the school staff age and training also had significant and interesting correlation patterns.

School Holding Power

The school dropout rate, or its reverse which is commonly referred to as school "holding power," has served as a quantitative criterion of school performance. The holding power criterion assumed that completion of formal schooling was a necessarily desirable goal.[25]

Using holding power as a criterion measure of "school quality," a 1969 study by Laabs[26] demonstrated that socioeconomic variables were predominant in explaining holding power. He also found some relationship between school related factors (finance and staff) and staying in school.

Peterson and his associates[27] demonstrated a positive correlation between dropouts and the number of teachers with less than four years preparation, and a negative

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[25] Wilbur, p. 1.

[26] Charles William Laabs, An Examination of Relationships Between Certain School Variables and Pupil Holding Power in Selected School Districts (Ed.D. dissertation, New York: Columbia University, 1969).

[27] Leroy Peterson, Richard A. Rossmiller, Stewart North, and Howard Wakefield, Economic Impact of State Support Models on Educational Finance (Madison, Wisconsin: University of Wisconsin, USOE Cooperative Research Paper No. 1495, 1963).

or inverse correlation between dropouts and mean teacher salaries. A Ford Foundation study revealed that increased expenditure reduced the dropout rate but did not increase achievement.[28]

Adaptability to Change

Studies at the Institute of Administrative Research located at Columbia University used correlates of educational "adaptability" in the early search for the quality school. "Adaptability" was defined as the capacity of school systems to take on new and more effective educational practices.[29] Mort, a leader and researcher in the Institute, together with Cornell found a positive relationship between adaptability of local school systems and their freedom to tax and spend.[30]

In summary, standardized achievement test results, school holding power, and adaptability to change have all been utilized as criterion measures of "educational quality" of output. Of the three, school standardized achievement test results have been employed most frequently in studies. These achievement measures of educational output have been used to measure relationships with school expenditures, specific purpose revenues, varied in-school and out-of-school characteristics, teacher quality, socioeconomic related variables and pupil self concept. Although school achievement test results have limitations noted in various studies reviewed,

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[28] Shaw School, The School and Community Work Related Education: A Ford Foundation Project Activity and Progress Report, 1961-1962 (St. Louis, Missouri: Shaw School, 1962).

[29] Wilbur, p. 1.

[30] Paul R. Mort and Francis G. Cornell, Adaptability of Public School Systems (New York: Teachers College Press, 1938). Cited by Roe L. Johns and E. L. Morphet in The Economics and Financing of Education: A Systems Approach (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969), p. 198.

they do represent the best single criterion of school performance as well as important and common objectives of the school program. This study used standardized achievement test results.

School and Nonschool Measures of Input

In phase one of this study, expenditure, as a measure of input, was used to ascertain its relationship to output, defined as elementary school center achievement. The relationship was analyzed to determine fixed performance or levels of "educational quality." The second phase of the study attempted to identify, define, and measure school and nonschool input correlates with the output criterion of high and low productivity. This section considers inputs for both phases.

Extensive data on pupils, teachers, classrooms and schools were used as independent variables in input-output studies. These measures of input may be classified according to Barro's[31] following taxonomy:

1. Individual pupil characteristics (ethnicity, socioeconomic status, home, family and neighborhood characteristics, age, prior performance, etc.).

2. Teacher and classroom characteristics.
   a. Group characteristics of the pupils (ethnic and socioeconomic composition, distribution and prior performance levels, etc., within the classroom).
   b. Teacher characteristics (age, training, experience, ability and personality measures if available, ethnic and socioeconomic background, etc.).
   c. Other classroom characteristics (measures of resource availability: class size, amount of instructional support, amount of materials, condition of physical facilities, etc.).

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[31] Stephen M. Barro, "An Approach to Developing Accountability Measures for the Public School," Phi Delta Kappan, LII (December, 1970), p. 202.

3. School characteristics.
   a. Group characteristics of the pupils (same as 2a above but based on the pupil population of the whole school.
   b. Staff characteristics (averages of characteristics in 2b for the school as a whole, turnover and transfer rates; characteristics of administrators -- same as 2b).
   c. Other school characteristics (measures of resource availability: age and condition of building, availability of facilities, amount of administrative and support staff, etc.).

As determinants of educational outcomes, variables designed to measure the characteristics classified in the above taxonomy were found to be significant in one or more studies.

School Inputs

The input-output study reported by Thomas[32] showed that the postulated relationship between levels of resource inputs (i.e. beginning salaries, number of books in the library, and experience of teachers) and mean test scores did exist; however, the manner in which money was spent appeared to be more important than the level of spending.

Project Talent involving 400,000 high school students from a sample of 1,353 high schools across the nation sought to determine correlates to a number of school outcomes such as achievement, going to college and staying in school. The study identified four important treatment factors. They were teacher salaries, teacher experience, number of books in the school library, and per pupil expenditure.[33]

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[32] James Alan Thomas, "Efficiency in Education: An Empirical Study," Administrator's Notebook, XI, No. 2 (October, 1962).

[33] John C. Flanagan, John T. Dailey, Marion F. Shaycoft, William A. Gorham, David B. Orr, and Isadore Goldberg, A Study and Follow-Up Study of Educational Plans and Decision in Relation to Aptitudes: Studies of the American High School (Pittsburgh: University of Pittsburgh, 1962), pp. 1-8.

The researchers concluded that these four factors remained important even after region, rural-urban status, and such factors as median family income, and quality of housing were held constant.[34]

Kiesling[35] identified (1) male teacher starting salary, (2) average number of years of teaching experience, (3) number of books in school library, (4) average class size, (5) pupil-teacher ratio, and (6) the percent of graduates going to college as variables which were directly related to achievement gains. The identification of these six variables resulted when he measured the effects of expenditures, intelligence quotients, socioeconomic levels represented by father's occupation, and some in-school variables on achievement test gains. His study encompassed grades four through eleven and pupils from a broad range of backgrounds.

Research employing the input-output model offered a tentative conclusion that money makes a difference in student performance. This is so if only because the quality of a school system's instructional staff appears to be related to that system's expenditure.

Evidence from research indicates that more "qualified" teachers tend toward school systems that pay them well.[36] For example, in California, certification and salary which were defined as teacher quality were found to explain achievement changes in children coming from low income families. Benson[37] concluded that the

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[34] Ibid., pp. 10-11.

[35] Kiesling, pp. 360-361.

[36] Wilbur, p. 17.

[37] Charles S. Benson, Report of the Senate Fact Finding Committee on Revenue and Taxation, State and Local Fiscal Relationships on Public Education in California (Sacramento: Senate of the State of California, 1965), p. 58.

"... caliber of teachers is the single most important factor."

Burkhead and his associates[38] examined correlates of a large number of school variables with secondary student performance in Chicago and Atlanta. The measures of student performance used included: intelligence, verbal and quantitative aptitude test scores, the schools' holding power rates, and post-high school education and employment. The authors concluded (1) that faculty salaries, teacher experience, and higher degrees were associated with determinants of school performance, although not to an extent that was statistically significant; (2) that teacher turnover appeared to be important when associated with determinants of school performance, and (3) that the age of the school building had some importance -- the older the building the higher the school performance.

A number of studies reviewed used class size as a variable.[39] Overall, this variable has not been found to be significant when investigated in relationship to other variables. Woodson[40] however, did find an inverse relationship between class size and pupil achievement.

Nonschool Inputs

Socioeconomic variables as indicators of input were emphasized in a number of recent studies. Consideration of socioeconomic and sociocultural factors arose when

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[38] Burkhead, pp. 68-72.

[39] See for example: Benson, pp. 41-42; Burkhead, p. 56; Coleman, et al., pp. 21-25; and Thomas, Efficiency in Education: A Study of the Relationship Between Selected Inputs and Mean Test Scores in a Sample of Senior High Schools.

[40] Marshall S. Woodson, Effect of Class Size as Measured by Achievement Test Criterion (New York: Columbia University, Institute of Administrative Research, February, 1968), p. 2.

the "culturally different" pupils exhibited limiting experiences and skills in school. Bernard[41] and other researchers commented that the educational performance of pupils was related to environmental and experiential factors, motivation, and self-esteem.

The most widely published research using socioeconomic measures of inputs was the massive 1966 Federal study called Equality of Educational Opportunity. Collecting data from 5,000 schools and sampling 600,000 students located throughout rural and metropolitan United States, the survey found family background influence and a student's attitude regarding his feeling of control over his destiny correlating highly with achievement.[42] One of the conclusions stressed in the report was that when minority children from homes which were nonsupportive of education were placed with school peers with strong educational background and family support for education, a significant increase in their achievement would result.[43] The report noted (1) that the motivations and aspirations of the student body itself would account for much of the variation in achievement within a given school, rather than the in-school characteristics surrounding facilities and instructional program; and (2) that the teacher characteristics, more than any other in-school factor, was attributed to the school-to-school variations over grades one through twelve.[44]

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[41] Harold W. Bernard, Psychology of Learning and Teaching (New York: McGraw-Hill Book Co., 1965), p. 228.

[42] Coleman, et al., p. 316.

[43] Ibid.

[44] Ibid., p. 317.

Coleman[45] concluded the school characteristics bore little influence on a child's achievement.

Coleman's survey was widely criticized for its statistical methodologies which over-emphasized the importance of nonschool variables related to achievement. Mayeske[46] following re-analyses using Coleman's data, suggested that school variables were more highly related to achievement than Coleman admitted and that school and nonschool variables were very closely related.

Bowles and Levin[47] seriously criticized the study and its findings. Their main criticism centered around the procedure of holding background variables constant, and then examining the school effect on the unexplained variance in achievement. They reported a contrasting finding which showed the quality of teachers, as reflected in their salaries and verbal scores, to be an important variable in affecting student achievement.[48]

A number of studies, although conducted on a more abbreviated scale than Coleman's study, reported similar findings. For example, Parelius[49] concluded that family background, social class, length of residence, and attitude toward school had

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[45] Ibid., p. 325.

[46] George W. Mayeske, Correlational and Regression Analysis of Differences Between the Achievement Levels of Ninth Grade Schools from the Educational Opportunities Survey (Washington, D. C.: USOE, DHEW, National Center for Educational Statistics, Division of Operational Analysis, 1968), pp. 54-55.

[47] Bowles and Levin, pp. 8-12.

[48] Samuel Bowles and Henry M. Levin, "More on Multicollinearity and the Effectiveness of Schools," The Journal of Human Resources, III (Summer, 1968), pp. 393-400.

[49] Robert James Parelius, Sociological Influences on the Achievement of Lower Class Negro Children (Washington, D. C.: USOE, DHEW, 1967).

important effects on achievement. Studies by Pierce and Mallory[50] and Sexton[51] found student achievement improved as family income rose. Rankin[52] compared high and low elementary school achievers in Detroit's school system and identified significantly different parental attitudes which included: level of parents' aspiration for child, amount of parent interest in child's school activity, encouragement of child's reading, and the extent to which parents shared experiences with the child and communicated with the school.

Studies which correlated various community characteristics with measures of output have also been attempted. In a follow-up analysis of Project Talent, Shaycoft[53] reported that pupils of low socioeconomic status in highest expenditure districts performed at much lower achievement levels than high socioeconomic status youths in lowest expenditure districts. A recent study of Florida's school districts by Daeufer and Rose[54] identified a high correlation between student achievement and both per pupil personal income and per pupil nonexempt equalized assessed valuation of property.

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[50] Pierce and Mallory, p. 80.

[51] Sexton, p. 27.

[52] Paul T. Rankin, Jr., The Relationship Between Parent Behavior and Achievement of Inner City Elementary School Children (Washington, D. C.: USOE, DHEW, 1967).

[53] Marion F. Shaycoft, The High School Years: Growth in Cognitive Skills (Pittsburgh: University of Pittsburgh, 1967).

[54] Carl J. Daeufer and Scott Rose, A Survey of the Relationship of Taxable Wealth, Aspects of School Funding, and the Twelfth Grade Achievement of Students Within School Districts of the State of Florida Unpublished report (Gainesville, Florida: University of Florida, 1971).

Mixture of Inputs

It is virtually impossible to demonstrate in a positive sense all relevant variables that have been included in a study. Goldstein[55] concluded that very few variables seemed strongly associated with ability or student growth. He asserted that student performance appeared to be a function of the interaction between individuals, peer, and family characteristics and school characteristics.

The contradictory nature of findings in some of the studies which were reviewed suggests that it is a mix of inputs which is needed to provide the desired educational outputs. Benson, Burkhead and Coleman, in their studies cited earlier in this review, supported this notion when each examined a mix of school and nonschool input variables with various measures of educational output. Gordon and Doxey[56] claimed that the appropriate mix of services for any given low income group was unknown. They suggested improvement in attendance and less time on discipline which would provide more class time as a factor to be considered.

The studies conducted by Osburn[57] and Ayer[58] noted a relationship between expenditures and results in education. Johns[59] concluded from a review of a number

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55 Bernard Goldstein, Barbara Steinberg, and Harry C. Bredemeier, Social and Cultural Factors Related to School Achievement (New Brunswick, New Jersey: Rutgers, The State University, 1967).

56 Edmund Gordon and Wikerson Doxey, Compensatory Education for the Disadvantaged, Programs and Practices: Preschool Through College (New York: College Entrance Examination Board, 1966).

57 Osburn, p. 3736.

58 Frederic L. Ayer, An Analysis of Certain Characteristics Related to the Quality of Education (Ph.D. dissertation, Columbia University, 1952).

59 Roe L. Johns and E. L. Morphet, The Economics and Financing of Education: A Systems Approach (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969), pp. 22-23.

of studies that "... there was a strong relationship between expenditures and the quality of education." In contrast, Lyle[60] suggested in his review of input-output studies that there were ample studies to refute the conclusion that per pupil expenditure alone is the key determinant of pupil achievement. For example, a 1964-1965 New York City program exceeding normal expenditures per pupil by $425 and designed to improve reading reported that a sufficient increase in achievement gains was associated with an appropriate mix of services, including new services.[61] Lyle[62] concluded that it required extensive increases in input to produce a small amount of output; therefore, rather than engage in massive spending increases per se, the focus should be on input-output studies that yield information regarding the best combination of services.

In summary, this section of the review considered a number of significant school and nonschool input variables. These included variables categorized under student, school and nonschool characteristics:

1. Student characteristics: personal income levels, family income levels, social class or family background, father's occupation, length of residence, pupil and parent attitude toward school, parents' aspiration for the child, self concept associated with amount of control over future, amount of communication between parent and school, encouragement of child's reading, amount of parents' interest in child's activity and percent of graduates participating in post-high school education

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[60] Lyle, p. 5-6.

[61] Ibid., pp. 17-18.

[62] Ibid., p. 12.

or employment.

2. School characteristics:

(a) Expenditures: total expenditure per pupil and expenditures for instructional salaries, instructional materials, supplies, and books.

(b) Teacher quality and influence: average teacher salary, male teacher starting salary, teacher scores on verbal tests, mean years of experience, mean class size, percentage of teachers with various degrees, pupil-teacher ratio, and teacher turnover.

(c) Other: age of school buildings, size of play areas, and school laboratories.

3. Nonschool characteristics: population density, size of school district, ethnic patterns, wealth trend of school district, expenditure level of district, percentage of population employed, and population change.

Input-Output Paradigm

Education, particularly elementary and secondary education, is characterized by a belated trend toward the development of specialized inputs.[63] As a complex social system, the school is in a continual process of resource interchange with its environment.[64] Central to this interchange of resources is the concept of productivity, or the relationship between the outcomes of education and human and

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[63] Harold F. Clark, Cost and Quality of Public Education (Syracuse: Syracuse University Press, 1963), pp. 7-11.

[64] Thomas, The Productive School, p. 2.

material resources which education consumes.[65] Levin[66] described an educational production paradigm in a recent article for the National Educational Finance Project. He used two equations, one which represented a production function for the educational enterprise, and the other which showed the relationship between the dollar budget of the educator and the transformation of the budget into school inputs. He emphasized that education operated on these two equations to tie educational expenditure (inputs) to educational outcome (outputs). More specifically, Levin[67] stated:

> Equation (1) represents a production function for an educational enterprise where A signifies a measure of educational outcomes, B denotes the nature of the student clientele, and $X_1, X_2, \ldots, X_n$ represents a set of inputs or resources used by the schools to produce education.
>
> (1) $A = f(B, X_1, X_2, \ldots, X_n)$
>
> Accordingly, [equation] (2) shows the relationship between the dollar budget accorded educational decision makers and the transformation of that budget into school inputs.
>
> (2) $R = P_1X_1 + P_2X_2 + \ldots + P_nX_n$
>
> [Here] , R represents the total dollar expenditures or budget allocated to the educational firm; P_1 signifies the price per unit of input X_1; and so on ....

Thus, to accomplish the greatest increase in A (outputs) for any given budget R, the education decision maker must ascertain that combination of the various inputs X that will maximize output within the limits of expenditures.

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[65] Burkhead, p. 2.

[66] Henry M. Levin, "The Effect of Different Levels of Expenditures on Educational Outputs," Economic Factors Affecting the Financing of Education, Vol. 2 (Gainesville, Florida: National Educational Finance Project, 1970), pp. 173-206.

[67] Ibid., pp. 176-177.

With the need for added investment in education and the rise in educational costs, the American society is demanding that more emphasis be placed upon the quantity and quality of output for a given level of expenditure. If he is to meet successfully this demand, the educator must increasingly recognize input-output relationships within the educational enterprise.

Lyle[68] suggested that measuring output per unit of input is the critical economic question for education today. However, researchers have encountered a dilemma whenever they have attempted to specify precisely input-output relationships in schools. A review of Lyle's definition of output supports rather clearly this measurement dilemma. He stated:

> A complete definition of output as measured by incremental achievement should include gains in academic achievement, social competence, citizenship and responsibility, judgment, self-confidence and creativeness.[69]

In addition, this measurement dilemma becomes even more complex when Lyle[70] related efficiency of production for a particular curriculum component, to school output by defining efficiency as "... maximizing increased achievement, measured on instruments valid for that curriculum and study group, per unit of funds expended for that component."

If administrators are to interpret the quality (output) of an educational system as a function of the quantity and quality of inputs, reliable judgments concerning input-output relationships based on empirical evidence are needed.

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[68] Lyle, p. 5.

[69] Ibid.

[70] Ibid.

In a 1962 study, Thomas[71] dealt with measurements of output as they relate to input. In order to simplify the problem he stated:

> I make a conceptual separation between long term outcomes and the short term measures of educational success. I deal with the latter, which are readily observed and measured.

Eighteen of the 50 variables he used were measures of output -- mean subscores on an achievement test battery. The 32 independent variables (input) were divided equally between community characteristics and characteristics of the school. His study offered two related conclusions; first, "the study gives support to the hypothesis that levels of outcome in education are related to inputs -- resources used, and characteristics of the school, home and community" and, second, "... the value of this technique of studying inputs and outputs in education has been established."[72]

Almost a decade later, Thomas[73] addressing his thoughts to educational administrators stated:

> Once we are willing to accept this notion that education is produced, we can talk about alternative methods of production.... The acceptance of the notion that there are alternative productive methods leads to an acceptance of resource allocation as a central responsibility of administration.

The idea of the need to relate input to output incorporates the notion of accountability. Although the term "accountability" has not acquired standard usage

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[71] Thomas, Efficiency in Education: A Study of the Relationship Between Selected Inputs and Mean Test Scores in a Sample of Senior High Schools, p. 4203.

[72] Ibid., p. 4204.

[73] Thomas, The Productive School, p. 3.

in education because of its newness, there is little doubt about its general meaning and import for the schools. The basic idea it conveys is that school systems and schools, more precisely the professional educator who operates them, should be held responsible for educational outcomes -- what children learn, and whether they learn to learn, to live creatively and to understand other people.

Attention to accountability occurs at all levels of government. Benson[74] recommended that state governments set minimum standards of student achievement in basic subjects and compute each district's cost for programs so as to allow students to meet or surpass these minimums. He urged a move from "standardized-opportunity-systems" to "differentiated-output-accountability systems."

Programming, Planning, Budgeting System (PPBS) methods and cost-benefit theory search for meaningful approaches to evaluate program achievements. This search utilizes input-output techniques to facilitate resource allocation decisions. Thus, whenever the relationship between educational expenditures and educational effectiveness is explored, the need is stressed to identify the appropriate mix of various inputs that will maximize the desired educational outputs.[75]

Since the mid-1930's Columbia University's Institute of Administrative Research has engaged in research aimed at educational performance -- "school quality." More recently as the Institute's development of "Indicators of Quality" progressed an input-output model of the educational system has been developed. This model is

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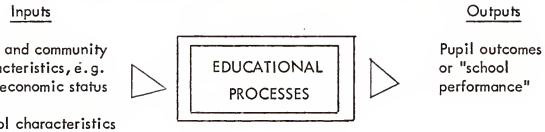
[74] Charles S. Benson, "A Possible Breakthrough in the Financing of Public Education," A paper read at Symposium on Operations Analysis of Education. (Washington, D. C.: USOE, DHEW, November 20, 1967).

[75] Pierce and Mallory, p. 1.

illustrated in Figure 1 below.[76]

Figure 1

Input-Process-Output Model of the Educational System



The model portrayed in Figure 1 relates input variables such as pupil background and school resources to process variables such as student achievement. Central to this conceptual model is the school program, which acts upon pupil, community and school inputs, and produces the output measured in student performance.

Wilbur's[77] report prepared for the Michigan Department of Education summarized well the need to relate inputs and outputs. He stated:

> This more complex and interrelated conceptualization [the input-output paradigm] of the educational process offers insight into the solution of the most vexing educational issue presently facing us, namely the equalization of educational opportunity.

Generalizations Based on the Review of Related Literature

The review of literature related to the problem of this study appears to justify the following generalizations:

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[76] Wilbur, pp. 1-2.

[77] Ibid., p. 18.

1. There is a need for input-output studies to provide empirical evidence that will enhance the development of educational decision making theory, similar to concepts developed by economists and system analysts.

2. A large number of studies has attempted to relate different inputs to different outputs; however, there still exists a need for further efforts to resolve the discrepancies associated with those socioeconomic and sociocultural factors that are interrelated with in-school factors which bear upon pupil performance.

3. When per pupil expenditures are treated in isolation of other variables and subsequently correlated with achievement as measured by standardized tests, a large increase in input is necessary to gain a small amount of output.

4. The central task is not to ascertain if expenditures are correlated significantly with achievement, but rather to investigate the appropriate mix of inputs that will generate maximum gains in outputs.

5. Measuring the relationship between achievement and expenditures to identify high and low productive elementary school centers, followed by efforts to ascertain specific student, in-school or community input variables in order to differentiate between the dichotomous groups of high and low productive elementary school centers lends a uniqueness to a study.

6. Independent (input) variables applied repeatedly in studies to identify correlates with outputs such,as pupil achievement and school holding power, may be utilized and organized under the following categories:

(1) Student characteristics: Associated with socioeconomic status and social class, such as family income, adjusted gross income, ethnic patterns, attitude toward school and academic confidence.

(2) School characteristics: Associated with teacher quality and expenditures, such as teacher salary, teacher experience, percentage of teachers with various degrees, teacher turnover, expenditures for instructional salaries, and other related variables such as age of school building.

(3) Nonschool characteristics: Pupil population change, voter patterns, population employed and attendance-membership ratio.

CHAPTER III
PRESENTATION OF THE DATA

Introduction

School and nonschool independent variables which may differentiate between high and low productive elementary school centers located in an urban school district were identified in this study. This identification was accomplished in two phases: (1) through the measurement of the relationship between current expenditures per pupil and median composite standardized achievement test scores of fourth grade pupils, and (2) through the use of discriminant analysis to determine variables which would predict high and low productivity. The data pertaining to these phases will be presented in this chapter.

The data are organized into three sections: (1) Identification of High and Low Productive Elementary School Centers, (2) Selection of the School and Nonschool Independent Variables Used in the Discriminant Analysis, and (3) Identification of Variables Predictive of High and Low Productive Elementary School Centers.

The first section includes: (1) achievement and expenditure data for the identified elementary school centers in each high (H) and low (L) group, (2) the residual scores or differences between actual elementary school center achievement and its predicted achievement, and (3) the simple regression equation which represents the measured relationship of achievement and expenditure, or average productivity.

The second section contains the school and nonschool variables selected for use in discriminant analyses or in predicting elementary school productivity.

In the third section, six discriminant functions, which produced the most efficient classification of the urban elementary school centers into high or low productive groups, are described.

In the Appendix are tables which show basic data associated with the school and nonschool independent variables selected for use in phase two. In addition, the Appendix contains an intercorrelation matrix table and a means and standard deviation table of the school and nonschool independent variables used in the study.

Identification of High and Low Productive Elementary School Centers

Using current expenditures per pupil in average daily membership (ADM) as the independent variable (X), and elementary school center median composite fourth grade achievement test results as the dependent variable (Y), a line of regression was computed. The regression line represented the average productivity for the elementary school centers serving pupils in grades one through six. Achievement data for the school year 1969-1970 were collected for each elementary school center. Expenditure data were obtained from the 1968-1969 school year records.

The computer procedure used was program number BMDO2R, Regression Analysis, as described in BMD Biomedical Computer Programs.[1] To predict achievement ($\hat{Y}$) from a given level of current expenditures per pupil ADM (X), a simple

[1] W. J. Dixon (ed), BMD Biomedical Computer Programs (Berkeley: University of California Press, 1970), pp. 233-269.

regression analysis was performed. The regression equation developed was $\hat{Y} = b(X) + a$. In this procedure, $\hat{Y}$ represented the predicted achievement score for an elementary school center on the criterion variable. The X represented the current expenditure level per pupil, and the a and b were two constants to permit variation in scale of measurements and the relative rate of change in the two variables.[2]

High and Low Productive Elementary School Centers

The current expenditure data per pupil (ADM) and median composite achievement data were assembled for the 68 elementary school centers serving pupils in grades one through six. The achievement data represented the median composite score for fourth grade pupils on the Iowa Tests of Basic Skills administered in October, 1969. The school district's mean composite median achievement grade placement was 3.34 with a standard deviation of 0.56. The mean for the 68 elementary school center's per pupil expenditure was $472.45 with a standard deviation of $111.05. The correlation between achievement and expenditures was 0.39, and was significant at the 0.01 level of confidence. A regression line was formed using these two variables. The regression equation was:

$$\hat{Y} = -0.00199X + 4.2897$$

The standard error of estimate (S_e) was 0.52. The median achievement, predicted achievement, residual score, and current expenditures per (ADM) for all of the 68 elementary school centers are presented in Table 1. Using a criterion of three-fourths of a standard error of estimate above or below the regression line of average

[2] David J. Fox, The Research Process in Education (New York: Holt, Rinehart and Winston, Inc., 1969), p. 227.

Table 1

COMPUTED RESULTS OF SIMPLE REGRESSION ANALYSIS FOR SIXTY-EIGHT ELEMENTARY SCHOOL CENTERS

Elementary School Center No.	Median Achievement	Predicted Achievement	Residual Scores	Current Expenditures PP ADM	Elementary School Center No.	Median Achievement	Predicted Achievement	Residual Scores	Current Expenditures PP ADM
ESC_{01}	3.80	3.54	0.26	376.00	ESC_{18}	3.30	3.37	-0.07	459.00
ESC_{02}	2.90	3.17	-0.27	561.00	ESC_{19}	2.80	3.15	-0.35	573.00
ESC_{03}	2.90	3.15	-0.25	572.00	ESC_{20}	3.40	3.57	-0.17	362.00
ESC_{04}	3.80	3.62	0.18	336.00	ESC_{21}	3.00	3.03	-0.03	631.00
ESC_{05}	3.40	3.29	0.11	503.00	ESC_{22}	3.00	3.11	-0.11	591.00
ESC_{06}	3.40	3.56	-0.16	367.00	ESC_{23}	3.20	3.16	0.04	565.00
ESC_{07}	3.00	3.47	-0.46	413.00	ESC_{24}	2.80	3.39	-0.59	449.00
ESC_{08}	4.40	3.57	0.83	358.00	ESC_{25}	3.90	3.51	0.39	392.00
ESC_{09}	3.60	3.21	0.39	542.00	ESC_{26}	3.40	3.52	-0.12	384.00
ESC_{10}	4.20	3.43	0.77	433.00	ESC_{27}	4.90	3.52	1.38	386.00
ESC_{11}	2.90	3.18	-0.28	556.00	ESC_{28}	3.20	3.56	-0.36	366.00
ESC_{12}	3.70	3.54	0.16	373.00	ESC_{29}	3.30	3.43	-0.13	433.00
ESC_{13}	2.80	3.50	-0.70	393.00	ESC_{30}	3.20	3.24	-0.04	524.00
ESC_{14}	2.90	3.28	-0.38	507.00	ESC_{31}	4.60	3.45	1.15	419.00
ESC_{15}	4.00	3.41	0.59	443.00	ESC_{32}	3.00	3.50	-0.50	395.00
ESC_{16}	3.40	3.51	-0.11	390.00	ESC_{33}	3.00	3.49	-0.49	400.00
ESC_{17}	3.00	3.48	-0.48	407.00	ESC_{34}	4.40	3.52	0.88	386.00

Table 1 Continued

Elementary School Center No.	Median Achievement	Predicted Achievement	Residual Scores	Current Expenditures PP ADM	Elementary School Center No.	Median Achievement	Predicted Achievement	Residual Scores	Current Expenditures PP ADM
ESC_{35}	3.10	2.93	0.17	680.00	ESC_{52}	2.80	3.00	-0.20	648.00
ESC_{36}	3.20	2.41	0.79	944.00	ESC_{53}	2.80	3.07	-0.27	613.00
ESC_{37}	4.30	3.38	0.92	458.00	ESC_{54}	3.70	3.47	0.23	413.00
ESC_{38}	4.20	3.53	0.67	381.00	ESC_{55}	2.80	3.36	-0.56	465.00
ESC_{39}	3.30	3.44	-0.14	426.00	ESC_{56}	3.50	3.29	0.21	502.00
ESC_{40}	3.00	3.47	-0.47	413.00	ESC_{57}	2.90	3.21	-0.31	539.00
ESC_{41}	3.40	3.46	-0.06	414.00	ESC_{58}	2.80	3.26	-0.46	517.00
ESC_{42}	2.90	3.41	-0.51	441.00	ESC_{59}	2.80	3.18	-0.38	559.00
ESC_{43}	2.80	3.04	-0.24	628.00	ESC_{60}	2.80	2.95	-0.15	670.00
ESC_{44}	4.10	3.57	0.53	362.00	ESC_{61}	2.90	3.36	-0.46	465.00
ESC_{45}	4.40	3.47	0.93	413.00	ESC_{62}	2.90	2.96	-0.06	665.00
ESC_{46}	3.30	3.67	-0.37	310.00	ESC_{63}	3.00	3.01	-0.01	641.00
ESC_{47}	3.10	3.46	-0.36	416.00	ESC_{64}	4.20	3.54	0.66	373.00
ESC_{48}	2.80	3.45	-0.65	422.00	ESC_{65}	3.20	3.49	-0.29	400.00
ESC_{49}	3.40	3.53	-0.13	379.00	ESC_{66}	3.00	3.16	-0.16	566.00
ESC_{50}	2.90	3.42	-0.52	438.00	ESC_{67}	3.10	3.49	-0.39	400.00
ESC_{51}	4.80	3.23	1.57	533.00	ESC_{68}	2.90	3.51	-0.61	388.00

productivity, a $\pm$ 0.39 cutoff point was established to determine high and low productive elementary school centers.

In applying the criterion, 15 elementary school centers were found with a residual score of + 0.39 or more, and were identified in the high (H) group. Fifteen elementary school centers with a residual score of -0.39 or less were identified in the low (L) group. Table 2, shows the median achievement, predicted achievement, residual score and current expenditures per (ADM) for these identified elementary school centers.

The results of the simple regression analysis identified 15 high (H) and 15 low (L) productive elementary school centers which constituted the criterion or dependent variable employed in the discriminant analysis procedures in phase two of the study. Figure 2, presents a graphic portrayal of the line of regression predicting average productivity for all of the 68 elementary school centers. The 15 plotted points above the dotted line z and the 15 plotted points below the dotted line w represent the high and low productive elementary school centers.

Selection of the School and Nonschool Independent Variables Used in the Discriminant Analysis

Prior to performing the discriminant analysis procedures of phase two the school and nonschool independent (input) variables were identified and selected. This section consists of (1) the basis used to guide the selection of the variables, (2) the selected school and nonschool independent (input) variables, and (3) the various combinations of the independent (input) predictor variables used in the discriminant analysis procedures.

The selection of the independent variables was based upon:

Table 2

URBAN SCHOOL DISTRICT'S IDENTIFIED HIGH AND LOW PRODUCTIVE ELEMENTARY SCHOOL CENTERS

High Productive Centers					Low Productive Centers				
Elementary School Center No.	Median Achievement	Predicted Achievement	Residual $3/4\ S_e = +0.39$	Current Expenditures PP ADM	Elementary School Center No.	Median Achievement	Predicted Achievement	Residual $3/4\ S_e = -0.39$	Current Expenditures PP ADM
ESC_{08}	4.4	3.57	0.83	358.00	ESC_{07}	3.0	3.47	-0.46	413.00
ESC_{09}	3.6	3.21	0.39	542.00	ESC_{13}	2.8	3.50	-0.70	393.00
ESC_{10}	4.2	3.43	0.77	433.00	ESC_{17}	3.0	3.48	-0.48	407.00
ESC_{15}	4.0	3.41	0.59	443.00	ESC_{24}	2.8	3.39	-0.59	449.00
ESC_{25}	3.9	3.51	0.39	392.00	ESC_{32}	3.0	3.50	-0.50	395.00
ESC_{27}	4.9	3.52	1.38	386.00	ESC_{33}	3.0	3.49	-0.49	400.00
ESC_{31}	4.6	3.45	1.15	419.00	ESC_{40}	3.0	3.47	-0.47	413.00
ESC_{34}	4.4	3.52	0.88	386.00	ESC_{42}	2.9	3.41	-0.51	441.00
ESC_{36}	3.2	2.41	0.79	944.00	ESC_{48}	2.8	3.45	-0.65	422.00
ESC_{37}	4.3	3.38	0.92	458.00	ESC_{50}	2.9	3.42	-0.52	438.00
ESC_{38}	4.2	3.53	0.67	381.00	ESC_{55}	2.8	3.36	-0.56	465.00
ESC_{44}	4.1	3.57	0.53	362.00	ESC58	2.8	3.26	-0.46	517.00
ESC_{45}	4.4	3.47	0.93	413.00	ESC_{61}	2.9	3.36	-0.46	465.00
ESC_{51}	4.8	3.23	1.57	533.00	ESC_{67}	3.1	3.49	-0.39	400.00
ESC_{64}	4.2	3.54	0.66	373.00	ESC_{68}	2.9	3.51	-0.61	388.00

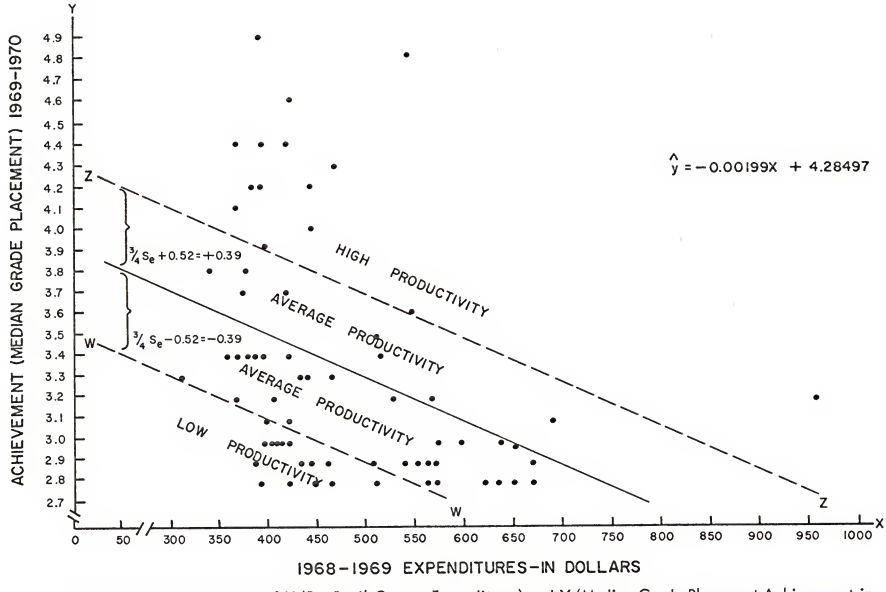

Figure 2. Scatter Diagram of X (Per Pupil Current Expenditures) and Y (Median Grade Placement Achievement in Grade 4) for 68 Elementary School Districts in an Urban School District.

1. A review of related literature including empirical studies, which identified various correlates to elementary school performance as measured by school achievement.

2. The urban school district's central office reports, superintendent's reports, and other regional and national reports, from which quantifiable data were located in order to construct measures of the variables previously identified by the research literature.

From these sources, 25 school and nonschool variables were finally selected. Summarized information for these independent variables is presented in Table 3, which includes the variable numbers, variable titles and descriptions. Data were collected for the 1968-1969 school year unless otherwise indicated within Table 3.

From the composite of the 25 variables, various combinations were formed in order to predict elementary school center productivity. These variables were categorized into sets of school and nonschool, decision making related, nondecision making related and student characteristics. These sets were made to clarify the interpretation of their interrelated affects and to provide a systems design.

Five sets of the 25 independent predictor variables used in the discriminant analysis procedures and their variable numbers are presented here.

Set I. Student Characteristics: Socioeconomic, social status and personal background of pupils: X_1, X_2, X_3, X_4, X_5, X_{20}, X_{21}, X_{22}.

Set II. School Related Characteristics: Staff, pupils, school expenditures, and conditions of facilities: (a) staff experience, training, salary, morale, turnover, (b) personal background of pupils, (c) elements of expense of education, and (d) pupil-teacher ratios and age of school facilities: X_7, X_8, X_9, X_{10}, X_{11},

Table 3

SUMMARY OF SELECTED SCHOOL AND NONSCHOOL INDEPENDENT VARIABLES USED TO PREDICT ELEMENTARY SCHOOL CENTER PRODUCTIVITY

No.	Variable Title	Description
1	Adjusted Gross Income	Adjusted gross income per pupil ADM (1966 Federal Income Tax data and ADM for 1968-69)
2	Income Below $3,000	Percent of Federal income tax returns with annual income less than $3,000 for 1966
3	Income Above $10,000	Percent of Federal income tax returns with annual income more than $10,000 for 1966
4	Nonwhite Pupil Population	Percent of nonwhite pupil population
5	Pupils - Low Income Families	Percent of pupils from low income families
6	Population Employed	Percent of elementary school center population employed for 1966
7	Teachers' Salary	Mean teacher salary
8	Staff - Without a Degree	Percent of certificated staff without a degree
9	Staff - Master's Degree	Percent of certificated staff with a master's degree or its equivalent
10	Teacher Experience	Mean teaching years of certificated staff
11	Nonwhite Professional Staff	Percent of nonwhite professional staff
12	Teacher Morale Factor	Mean of teacher survey factor on morale
13	Staff Change	Percent of certificated staff turnover from 1967-68 to 1968-69
14	Pupil-Teacher Ratio	Ratio of pupils in average daily membership to staff average daily membership teaching time
15	Male Teachers Employed	Percent of male teachers employed

Table 3 Continued

No.	Variable Title	Description
16	Expenditures - Instructional Salaries	Percent of total current expenditures spent for instructional salaries
17	Expenditures - Supplies, Books, Materials	Percent of total current expenditures funded for instructional supplies, books, and materials
18	Expenditures - Federal Sources	Percent of total current expenditures from Federal sources
19	Attendance-Membership Ratio	Ratio of average daily attendance to average daily membership
20	Pupil - Psychological Referrals	Percent of pupil psychological referrals
21	Pupil - Academic Confidence Factor	Percent of pupil affirmative responses for student academic confidence factor
22	Pupil - Valence Toward School Factor	Percent of pupil affirmative responses for student valence toward school factor
23	Pupil Change	Percent change in pupil average daily membership from 1967-68 to 1969-70 school year
24	Age - School Facilities	Age of school building in years as of the 1968-69 school year
25	Voters 'For' Tax Levy	Percent of voters 'for' school tax levy

X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17}, X_{18}, X_{19}, X_{20}, X_{21}, X_{22}, X_{24}.

Set III. Nonschool Related Characteristics: Socioeconomic, sociocultural and social status community factors: X_1, X_2, X_3, X_4, X_5, X_6, X_{19}, X_{23}, X_{25}.

Set IV. Administrative Decision Making Related Characteristics: School and Nonschool: Opportunity exists for school leadership to influence decisively: X_4, X_5, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17}, X_{18}, X_{20}, X_{21}, X_{22}, X_{24}.

Set V. Administrative Nondecision Making Related Characteristics: School and Nonschool: Opportunity does not exist for school leadership to influence decisively: X_1, X_2, X_3, X_6, X_{19}, X_{23}, X_{25}.

Identification of Variables Predictive of High and Low Productive Elementary School Centers

A stepwise multiple discriminant analysis was performed to identify the variables predicting the high and low elementary school centers. It used the criterion variable of high and low productive elementary school centers as the dependent variable, and various combinations of the 25 school and nonschool variables as the independent variables. The procedure was called program number BMDO7M, Stepwise Discriminant Analysis, as described in BMD Biomedical Computer Programs.[3]

This procedure provided a multivariate analysis in a stepwise manner of variable data organized by elementary school centers which were dichotomously grouped. The groups were designated as high (H) productive elementary school centers and

[3] Dixon, pp. 214a-214t.

low (L) productive elementary school centers.

For each problem set, the task was to determine the variable or combination of school and nonschool variables which would predict high or low productivity in the urban school district. Discriminant analysis procedures were employed. The general form of discriminant analysis is normally used to examine differences among an a priori classification of groups. The examination of these differences can be accomplished by performing ordinary F-tests of significance between the sampled elementary school center groups of high productivity and low productivity on each of the variables included in the problem set. Actually, this ordinary F-test assessment did occur at step 0 of the analysis. However, this approach lacks efficiency in two respects. First, the approach overlooks the interrelationship among the variables. Second, it does not provide for an assessment of the relative power of each of the variables in determining the differences among the high and low productive elementary school centers.[4]

Stepwise discriminant analysis, using the Fisher F as the statistic, in contrast to the more general form of discriminant analysis, was used in this study. Operating in a stepwise manner the variable selected at each step in any one problem set which gave the greatest improvement in classification was entered. At each step and on the basis of all variables previously entered into the discriminant function the significant difference between the dichotomized groups was determined. In other words, the stepwise discriminant analysis sought some linear combination of these variables

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[4] Harry E. Anderson, "Regression, Discriminant Analysis, and a Standard Notation for Basic Statistics," in Raymond B. Cattell (ed), Handbook of Multivariate Experimental Psychology (Chicago: Rand McNally and Company, 1966), p. 168.

that would maximize the "between-group" difference relative to the "within-group" difference.[5] Thus, the multivariate samples were reduced to the univariate case and the maximum differences between the high productive elementary school center group and the low productive elementary school center group was ascertained.

In each step of the analytical procedure, the variable being brought into the computation was the one having the largest F-to-enter value. In this program, an F value for inclusion of 0.01 was used as a cutoff point. Variables which, if brought into the computation, had an F value lower than this, were omitted from the prediction equations or discriminant function. This procedure also provided for the rejection of any variable which, after being accepted, experienced a drop in its F ratio down to some preselected level due to the effects of the addition of later variables. In this calculation the rejection level was 0.005. This was found to be sufficiently low so that no variable, once having been accepted, was rejected.

In order to restrict the number of variables included in the discriminant function and yet permit maximum classification of the elementary school centers into one of the two groups, either high (H) productive or low (L) productive, the following criteria were used:

1. A variable was included when it met two preferred conditions: if it had improved the percent of accurate classification, and if it had an F-to-enter associated probability of 0.05 or less.

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[5] Ibid., p. 169.

2. A variable was included when the major condition of improving the percent of accurate classification was not met; and yet that variable's F-to-enter associated probability was 0.05 or less.

The programming permitted analyses to proceed beyond these criterion points. In actual practice, the prediction equations and discriminant function were computed for all the variables included in each combination set, regardless of the fact that, in some instances, 100 percent classification was achieved prior to analyzing the remaining variables.

To determine the discriminant function for each problem set, four essential data components were examined at each step of the procedures. The first, variable included and F-to-remove, showed the maximal mix of independent variables at that step and showed the related contribution, in a descending order, that each variable made to the discriminant function.

The second component, variables not included and F-to-enter, showed the predictive contribution of each variable to a set of discriminating variables which were to be included in the next analytical step. The variable entered at the next step had the largest F-value associated with the probability that its contribution to the discriminant function would provide the greatest likelihood of differentiating between the high and the low productive elementary school centers. A variable, to be significant in the discrimination and thus included in the set of prediction equations, had to have an associated probability of 0.05 or less.

A discriminant function, the third component was composed of a set of two prediction equations, one of which predicted the high productive elementary school centers and the other the low.

The final component was a classification matrix represented by a 2 x 2 contingency table. The table showed the joint occurrence of pairs of scores on two variables in a group.[6] At each step the 15 cases of high and the 15 cases of low productive elementary school centers were classified as being either high productive or low productive by the prediction equations in the discriminant function.

Six Discriminant Functions

Six discriminant analyses were performed in this investigation. These included a composite analysis of all the school and nonschool independent predictor variables selected for this study, and five analyses of the combinations of these independent variables. The combinations were entitled: Set I - Student Predictor Variables, Set II - School Related Predictor Variables, Set III - Nonschool Related Predictor Variables, Set IV - Administrative Decision Making Related Predictor Variables, and Set V - Administrative Nondecision Making Related Predictor Variables.

The results of the discriminant analyses are presented in this section. Information on the two prediction equations for each discriminant function is summarized in separate tables. Each equation consists of a constant (K) and a function of the variables (X) which met the previously defined criteria. In each table of summary information, a broken line is drawn to separate those discriminating variables which meet the F-to-enter and maximum percent of accurate classification criteria from those variables which do not.

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6 Gene V. Glass and Julian C. Stanley, Statistical Methods in Education and Psychology (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), p. 160.

Composite of school and nonschool predictor variables

It was found that four of the 25 school and nonschool variables formed the discriminant function when judged by the F-to-enter and percent of accurate classification criteria. The discriminant function for classification purposes is described by the following equations:

$$\text{High Productive Group} = -45.73(K) - 62.02X_5 + 95.47X_{18} - 65.96X_8 + 17.13X_{12}$$

$$\text{Low Productive Group} = -33.83(K) + 50.96X_5 - 16.38X_{18} + 38.65X_8 + 11.47X_{12}$$

Presented in Table 4 are the variables, F-to-enter values, associated probabilities and percent of accurate classification.

Table 4

SUMMARY INFORMATION FOR THE DISCRIMINANT FUNCTION ANALYSIS OF TWENTY-FIVE SCHOOL AND NONSCHOOL VARIABLES

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
1	5	Pupils - Low Income Families	73.22	<0.001	86.66
2	18	Expenditures - Federal Sources	9.00	0.006	93.33
3	8	Staff - Without a Degree	13.09	0.002	100.00
4	12	Teacher Morale Factor	9.20	0.006	100.00
5	10	Teacher Experience	3.07	0.090(NS)[a]	------
6	24	Age - School Facilities	3.08	0.090(NS)	------
7	17	Expenditures - Supplies, Books, Materials	3.79	0.060(NS)	------
8	4	Nonwhite Pupil Population	3.18	0.090(NS)	------
9	25	Voters 'For' Tax Levy	2.91	0.100(NS)	------
10	21	Pupil - Academic Confidence Factor	2.07	0.164(NS)	------
11	3	Income Above $10,000	0.85	0.371(NS)	------

Table 4 Continued

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
12	20	Pupil - Psychological Referrals	0.72	0.412(NS)	------
13	19	Attendance-Membership Ratio	0.66	0.434(NS)	------
14	22	Pupil - Valence Toward School Factor	1.08	0.316(NS)	------
15	6	Population Employed	0.61	0.453(NS)	------
16	7	Teachers' Salary	0.22	0.636(NS)	------
17	23	Pupil Change	0.09	0.689(NS)	------
18	14	Pupil-Teacher Ratio	0.14	0.676(NS)	------
19	9	Staff - Master's Degree	0.13	0.680(NS)	------
20	1	Adjusted Gross Income	0.15	0.672(NS)	------
21	2	Income Below $3,000	0.11	0.686(NS)	------
22	11	Nonwhite Professional Staff	0.20	0.649(NS)	------
23	15	Male Teachers Employed	0.10	0.688(NS)	------
24	13	Staff Change	0.07	0.685(NS)	------
25	16	Expenditures - Instructional Salaries	0.00	0.425(NS)	------

[a] NS refers to nonsignificant.

In Table 4 at step three, 100 percent accurate classification of the 30 elementary school centers was obtained. The variable entered at step 4 was significant at the 0.05 level of confidence; therefore, it was included in the discriminant function. After step 4, the percent of accurate classification for the remaining 21 variables was omitted because a 100 percent perfect classification had been obtained.

Set I - student predictor variables

Two out of the eight student characteristic variables, which included socio-economic and in-school student characteristics, formed the discriminant function after applying the twofold criteria of the F-to-enter value and the maximum percent of accurate classification. The discriminant equations derived were as follows:

High Productive Group = $-286.77(K) - 218.20X_5 + 934.82X_{22}$

Low Productive Group = $-255.75(K) - 162.39X_5 + 872.34X_{22}$

Presented in Table 5 are the variables, F-to-enter values, associated probabilities, and percent of accurate classification for the Set I analysis. The variables listed below the broken line failed to meet the critical value of F and therefore were not included in the discriminant function.

Table 5

SUMMARY INFORMATION FOR THE DISCRIMINANT FUNCTION ANALYSIS OF STUDENT CHARACTERISTICS

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
1	5	Pupils - Low Income Families	73.22	< 0.001	86.66
2	22	Pupil - Valence Toward School	5.13	0.030	93.33
3	4	Nonwhite Pupil Population	3.17	0.083(NS)[a]	96.66
4	3	Income Above $10,000	1.95	0.172(NS)	96.66
5	2	Income Below $3,000	3.70	0.063(NS)	96.66
6	20	Pupil - Psychological Referrals	1.57	0.221(NS)	96.66
7	1	Adjusted Gross Income	1.17	0.291(NS)	96.66
8	21	Pupil - Academic Confidence Factor	0.22	0.634(NS)	96.66

[a] NS refers to nonsignificant.

Set II - school related predictor variables

It was found that five variables out of the 16 school related variables formed the discriminant function for the school characteristics studied. These variables met the critical value of F used in this study. The discriminant function equations associated with the five variables were as follows:

High Productive Group = $-403.43(K) + 26.99X_{11} + 290.44X_8$

$$-1.28X_{10} + 1086.02X_{16} + 209.53X_{15}$$

Low Productive Group = $-469.04(K) + 41.15X_{11} + 373.87X_{8}$

$$-2.46X_{10} + 1176.53X_{16} + 253.72X_{15}$$

Presented in Table 6 are the variables, F-to-enter values, associated probabilities and percentages of accurate classification for all 16 variables included in the Set II analysis. After step 5, no single variable was significant beyond the 0.05 level of confidence.

Table 6

SUMMARY INFORMATION FOR THE DISCRIMINANT FUNCTION ANALYSIS OF SCHOOL RELATED CHARACTERISTICS

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
1	11	Nonwhite Professional Staff	13.50	< 0.001	76.66
2	8	Staff - Without a Degree	10.49	0.003	83.33
3	10	Teacher Experience	9.14	0.006	90.00
4	16	Expenditures - Instructional Salaries	6.55	0.016	96.66
5	15	Male Teachers Employed	9.26	0.006	90.00
6	12	Teacher Morale Factor	3.36	0.077(NS)[a]	96.66
7	17	Expenditures - Supplies, Books, Materials	2.99	0.094(NS)	100.00
8	22	Pupil - Valence Toward School	2.42	0.131(NS)	------
9	24	Age - School Facilities	3.09	0.091(NS)	------
10	21	Pupil - Academic Confidence	0.26	0.613(NS)	------
11	20	Pupil - Psychological Referrals	0.15	0.670(NS)	------
12	9	Staff - Master's Degree	0.24	0.624(NS)	------
13	13	Staff Change	0.16	0.666(NS)	------
14	7	Teachers' Salary	0.12	0.682(NS)	------
15	18	Expenditures - Federal Sources	0.04	0.665(NS)	------
16	14	Pupil-Teacher Ratio	0.02	0.619(NS)	------

[a] NS refers to nonsignificant.

Table 6 indicates that a decrease in the accuracy of classification occurred at step 5. Perfect classification was obtained for the school related variables analyzed at step 7.

Set III - nonschool related predictor variables

Nine nonschool related variables constituted Set III. It was found that four variables formed the discriminant function when judged by the F-to-enter values and the percent of accurate classification criteria.

The discriminant function for classification purposes is described by the following equations:

$$\text{High Productive Group} = -5670.04(K) + 901.65X_5 + 12045.38X_{19} - 304.24X_4 + 14.11X_{25}$$

$$\text{Low Productive Group} = -5367.00(K) + 930.15X_5 + 11735.32X_{19} - 284.85X_4 - 15.57X_{25}$$

Summary information for the solution of the stepwise discriminant analysis of Set III is presented in Table 7.

Table 7

SUMMARY INFORMATION FOR THE DISCRIMINANT FUNCTION ANALYSIS OF NONSCHOOL RELATED CHARACTERISTICS

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
1	5	Pupils - Low Income Families	73.22	<0.001	86.66
2	19	Attendance-Membership Ratio	5.31	0.028	93.33
3	4	Nonwhite Pupil Population	10.17	0.004	96.66
4	25	Voters 'For' Tax Levy	7.88	0.009	100.00
5	6	Population Employed	3.47	0.072(NS)[a]	------
6	1	Adjusted Gross Income	0.18	0.655(NS)	------
7	23	Pupil Change	0.19	0.650(NS)	------

Table 7 Continued

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
8	3	Income Above $10,000	0.10	0.687(NS)	------
9	2	Income Below $3,000	0.50	0.494(NS)	------

[a] NS refers to nonsignificant.

Table 7 revealed that variable 25, at step four, was significant at the 0.05 level of confidence. At this step, the discriminant analysis produced a 100 percent accurate classification of the 30 elementary school centers.

Set IV - administrative decision making related predictor variables

Eighteen variables were grouped to form the predictor variables for Set IV. Four variables constituted the discriminant function when judged by the previously described criteria. The discriminant function equations associated with Set IV were as follows:

$$\text{High Productive Group} = -45.73(K) - 62.02X_5 + 95.47X_{18} - 65.96X_8 + 17.13X_{12}$$

$$\text{Low Productive Group} = -33.83(K) + 50.96X_5 - 16.38X_{18} + 38.65X_8 + 11.47X_{12}$$

The derived discriminant function for these four variables was identical to the discriminant function developed from the analysis of the composite of 25 school and nonschool predictor variables; therefore, the prediction equations presented here were identical to the equations cited for the composite function.

In Table 8, the variables, F-to-enter values, associated probabilities, and percent of accurate classification for the Set IV analysis are presented. The first four variables identically recount the data shown in the first four steps of the summary

Table 8

SUMMARY INFORMATION FOR THE DISCRIMINANT FUNCTION ANALYSIS OF ADMINISTRATIVE DECISION MAKING RELATED VARIABLES

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
1	5	Pupils - Low Income Families	73.22	<0.001	86.66
2	18	Expenditures - Federal Source	9.00	0.006	93.33
3	8	Staff - Without a Degree	13.09	0.002	100.00
4	12	Teacher Morale Factor	9.20	0.006	100.00
5	10	Teacher Experience	3.07	0.090(NS)[a]	------
6	24	Age - School Facilities	3.08	0.090(NS)	------
7	17	Expenditures - Supplies, Books, Materials	3.79	0.060(NS)	------
8	4	Nonwhite Pupil Population	3.18	0.090(NS)	------
9	15	Male Teachers Employed	1.10	0.307(NS)	------
10	16	Expenditures - Instructional Salaries	0.70	0.418(NS)	------
11	13	Staff Change	0.37	0.555(NS)	------
12	20	Pupil - Psychological Referrals	0.34	0.571(NS)	------
13	21	Pupil - Academic Confidence	0.18	0.656(NS)	------
14	22	Pupil - Valence Toward School	0.06	0.683(NS)	------
15	9	Staff - Master's Degree	0.02	0.619(NS)	------
16	11	Nonwhite Professional Staff	0.01	0.567(NS)	------
17	14	Pupil-Teacher Ratio	0.01	0.566(NS)	------
18	7	Teachers' Salary	<0.01	0.485(NS)	------

[a] NS refers to nonsignificant.

information for the composite analysis of 25 school and nonschool variables presented in Table 4.

Set V - administrative nondecision making related predictor variables

It was found that two variables out of the total seven variables that constitute the administrative nondecision making related problem set formed the discriminant function when judged by the F-to-enter criterion of the study. The discriminant

equations derived were as follows:

$$\text{High Productive Group} = -3076.80(K) + 65990.01X_{19} - 212.62X_3$$

$$\text{Low Productive Group} = -2909.69(K) + 6423.87X_{19} - 241.97X_3$$

Presented in Table 9 are the variables, F-to-enter values, associated probabilities, and the percent of accurate classification for the Set V analysis. In Table 9 at step two, 96.66 percent of the 30 elementary school centers were accurately classified.

Table 9

SUMMARY INFORMATION FOR THE DISCRIMINANT FUNCTION ANALYSIS OF ADMINISTRATIVE NONDECISION MAKING RELATED VARIABLES

Step	No.	Variable Title	F-to-enter	Probability	Percent Accurate
1	19	Attendance-Membership Ratio	48.11	0.001	90.00
2	3	Income Above $10,000	8.78	0.006	96.66
3	1	Adjusted Gross Income	2.64	0.113(NS)[a]	93.33
4	25	Voters 'For' Tax Levy	1.50	0.230(NS)	93.33
5	6	Population Employed	0.88	0.360(NS)	93.33
6	2	Income Below $3,000	0.41	0.534(NS)	93.33
7	23	Pupil Change	0.07	0.687(NS)	93.33

[a] NS refers to nonsignificant.

Summary

In this chapter, data associated with identifying an urban school district's high and low productive elementary school centers were presented. Thirty elementary schools, 15 designated as high productive and 15 designated as low productive, represented the dependent or criterion variable in the six discriminant analyses per-

formed.

The school and nonschool independent variables used in the study were presented, including their basis for selection and their groupings for analysis. In each table of summary information, the variables ordered above the broken line represented discriminating variables. These variables met the critical value of F and the maximum percent of accurate classification criteria, and formed the discriminant function.

A summary of the groupings of independent variables and their discriminant analysis results are presented in Table 10. For each discriminant analysis performed, the prediction equations and the stepwise discriminating variables which were significant and which produced the maximum percent of accurate classification of the dichotomous criterion variables were shown.

Table 10

SUMMARY INFORMATION FOR THE SIX DISCRIMINANT ANALYSIS FUNCTIONS

Discriminant	Total No. Variables Included	Steps	Number and Title of Variables Included in the Function	No. Variables Significant at 0.05 level	Maximum Percent Accurate Classification
Composite of School and Nonschool Variables	25	1	X_5 - Pupils - Low Income Families	4	100.00 at Step 3 and 4
		2	X_{18} - Expenditures - Federal Sources		
		3	X_8 - Staff - Without a Degree		
		4	X_{12} - Teacher Morale Factor		
Set I - Student Characteristics	8	1	X_5 - Pupils - Low Income Families	2	93.33 at Step 2
		2	X_{22} - Pupil - Valence Toward School		
Set II - School Related Characteristics	16	1	X_{11} - Nonwhite Professional Staff	5	96.66 at Step 4 90.00 at Step 5
		2	X_8 - Staff - Without a Degree		
		3	X_{10} - Teacher Experience		
		4	X_{16} - Expenditures - Instructional Salaries		
		5	X_{15} - Male Teachers Employed		
Set III - Nonschool Related Characteristics	9	1	X_5 - Pupils - Low Income Families	4	100.00 at Step 4
		2	X_{19} - Attendance-Membership Ratio		
		3	X_4 - Nonwhite Population		
		4	X_{25} - Voters 'For' Tax Levy		

Table 10 Continued

Discriminant	Total No. Variables Included	Steps	Number and Title of Variables Included in the Function	No. Variables Significant at 0.05 level	Maximum Percent Accurate Classification
Set IV - Administrative Decision Making Related Characteristics	18	1 2 3 4	X_5 - Pupils - Low Income Families X_{18} - Expenditures - Federal Sources X_8 - Staff - Without a Degree X_{12} - Teacher Morale Factor	4	100.00 at Step 3 and 4
Set V - Administrative Non-decision Making Related Characteristics	7	1 2	X_{19} - Attendance-Membership Ratio X_3 - Income Above $10,000	2	96.66 at Step 2

CHAPTER IV
ANALYSIS AND DISCUSSION OF THE DATA

Introduction

The primary purpose of this study was to identify those school and nonschool variables which would differentiate between high and low productive elementary school centers in an urban school district. In accomplishing this purpose the specific aims of this study were to identify high and low productive elementary school centers, and to determine those school and nonschool independent variables that would predict high or low productivity.

Chapter III presented the data resulting from the investigation of the problem. In this present chapter, the data are analyzed and discussed. Toward this end, the chapter is divided into four major sections. They are: (1) Identifying the Criterion Variable for High and Low Productive Elementary School Centers, (2) Forming the Discriminant Functions, (3) Analyzing the School and Nonschool Independent Variables Predictive of Elementary School Productivity, and (4) Employing a Productivity Concept.

The first section examines the regression analysis and the statistically significant variation which produced the dichotomous criterion of high and low productive elementary school centers.

The second section discusses the data used in the discriminant analyses, the

analytic procedures employed to determine the six discriminant functions, and the efficacy of the discriminant functions to predict high or low productivity.

In the third section, six discriminant functions and their respective variables used to predict elementary school center productivity are analyzed.

A model for predicting elementary school productivity in an urban school district is constructed in the fourth section.

Identifying the Criterion Variable for High and Low Productive Elementary School Centers

The discussion in this section centers upon an analysis of the data relative to identifying the criterion variable of high and low productive elementary school centers.

Through regression analysis, the relationship between elementary school center median composite achievement test scores and per pupil current expenditures per ADM variables was analyzed. As a result, a regression line relating achievement to expenditure was drawn which represented average productivity. The regression analysis produced a correlation (r_{xy}) of -0.39 which was significant at the 0.01 level of confidence. The regression equation was:

$$\hat{Y} = -0.00199X + 4.28497$$

Each of the 68 elementary school centers was plotted on a graph (Figure 2). Some fell near the line and others were variously located above or below it. The important task was to locate those elementary school centers that fell into either the high productive or low productive categories. In order to avoid selection that represented statistically insignificant variation, two cutoff points were established. These cutoff points were three-fourths of a standard error of estimate (S_e) above or

below the line of regression.

The standard error of estimate was 0.52. Thus, the high (H) productive group was located at or above a S_e of +0.39, and the low (L) productive group was located at or below a S_e of -0.39.

Inaccurate predictions of $\hat{Y}$ from X were possible; for example, there was the probability that the estimate of $\hat{Y}$ from X could occur by chance. However, the dichotomous groups identified were judged to be different in elementary school productivity on the basis that the standard error of estimate represented the size of error in estimating Y from X.[1]

The standard error of estimate was used to set limits around a predicted score $\hat{Y}$ within which an elementary school center's actual score was likely to fall.[2] In other words, the achievement scores (Y) of the 68 elementary school centers which determined the prediction line, $\hat{Y} = -0.00199X + 4.28497$, came from what was roughly a bivariate normal distribution. Therefore, 54.68 percent had actual scores that lay within three-fourths of a S_e of their predicted score $\hat{Y}$. The 15 elementary school centers in the high (H) productive group and the 15 elementary school centers in the low (L) productive group represented about 45.32 percent of a distribution of scores which had a standard deviation of (S) of 0.56. This standard deviation was almost equal to the standard error of estimate of 0.52.

The identification procedure produced a fixed performance criterion which

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[1] Gene V. Glass and Julian C. Stanley, Statistical Methods in Education and Psychology (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), pp. 141-144.

[2] Ibid., p. 143.

differentiated the school centers with statistically significant variation. Thus, the first aim of the study which was to identify high and low productive elementary school centers was accomplished.

Forming the Discriminant Functions

To accomplish the primary purpose of this study six discriminant functions were formed. A set of two prediction equations was calculated for each discriminant function. These equations represented a function of several measurements of school and nonschool variables predictive of high or low productivity and classified elementary school centers into the two contrasting groups. The data collected for this study were subjected to stepwise discriminant analysis of the BMDO7M computer program.

Data Used in the Discriminant Analyses

The identified 15 high productive and 15 low productive elementary school centers constituted the dichotomously grouped criterion (output) variable data. Table 2 in Chapter II presents the grouped membership.

Various combinations of school and nonschool independent (input) variable characteristics were used. These encompassed a composite of the 25 selected school and nonschool variables, and five different combinations organized for analyses into problem sets. The five problem sets analyzed were: Set I - Student Predictor Variables, Set II - School Related Predictor Variables, Set III - Nonschool Related Predictor Variables, Set IV - Administrative Decision Making Related Predictor Variables, and Set V - Administrative Nondecision Making Related Predictor Variables. A descriptive summary of these independent school and

nonschool variables is found in Table 3.

Determining the Discriminant Function for the Problem Sets

To determine the discriminant function for the problem sets, stepwise discriminant analysis procedures were employed to examine differences among the sampled elementary school center groups of high and low productivity on each of the variables included in any one problem set.

Specifically, four essential data components were examined at each step of the procedure. They were: (1) variable included and F-to-remove, (2) variables not included and F-to-enter, (3) a set of two prediction equations, one of which predicted high productive elementary school centers and the other the low, and (4) a classification matrix which summarized the prediction results at each step of the analytical procedures.

F-to-enter criteria were used to restrict the number of variables included in the discriminant function and yet permit maximum classification of the elementary school centers into either high or low productivity groups. A variable was included when it met two preferred conditions, first; if it had improved the percent of accurate classification, and if it had an F-to-enter associated probability of 0.05 or less. Second, a variable was included when the major condition of improving the percent of accurate classification was not met, and yet that variable's F-to-enter associated probability was 0.05 or less.

Efficacy of the Prediction Equations

The discriminant function contained a set of two prediction equations. Each prediction equation consisted of a constant (K) and a function of weighted variables

(X). One of the two equations predicted high (H) productive elementary school centers and the other equation predicted low (L) productive elementary school centers. Using the discriminating weights developed by the discriminant analysis, the measured independent variables were calculated for each equation. These calculations disregarded the a priori dichotomously grouped criterion variable.

The calculated figures for the two predictive equations were the values for the discriminant function for the tested elementary school center, and the smaller of the two figures was chosen as the predictor of productivity. That is, whichever figure was smaller, for either the high productive or low productive elementary school center tested, it was that figure which predicted the high or low productivity.

At each step, the prediction results were summarized in the form of a classification matrix. The data within each classification matrix were used to determine the percent of accurate classification of elementary school centers.

The data within the classification matrix were also used to calculate the efficiency of the prediction equations. The efficiency of discrimination can be expressed in correlational form; that is, the relationship between the a priori dichotomously grouped criterion variable and the ability of the developed discriminant function to predict elementary school center productivity. A correlation technique used in this study to test the efficiency of discrimination was the tetrachoric correlation coefficient. The r_{tet} correlation coefficient is numerically equivalent to the Pearson product coefficient of correlation and required dichotomous variables which were normally distributed and linearly related.[3] When r_{tet}

[3] J. P. Guilford, Fundamental Statistics in Psychology and Education (New York: McGraw-Hill Book Company, Inc., 1956), p. 305.

was squared, the efficiency of the prediction equations in the discriminant function was expressed as a percentage of the variance accounted for by the variables included.

Analyzing School and Nonschool Independent Variables Predictive of Elementary School Productivity

Six Discriminant Functions

This section analyzes the six discriminant functions which produced the most efficient classification of the elementary school centers into high or low productive groups. Three parts of the technique are explicated: (1) the discriminating variables which met the criteria of F-to-enter and maximum percent of accurate classification, (2) the associated F-to-remove values for the variables included in the prediction equations for each discriminant function, and (3) the efficiency of the prediction equations in each discriminant function.

Composite of school and nonschool predictor variables

Twenty-five school and nonschool independent variables were selected to identify the variables which would differentiate between high and low productivity. F-tests were performed on each variable at step 0 to ascertain the significant differences between the contrasted groups. Thirteen of these 25 school and nonschool variables with 1 and 28 degrees of freedom were significant at the 0.05 level of confidence. Their titles, numbers, and F-to-enter values were: X_1- Adjusted Gross Income: 16.47; X_2- Income Below $3,000: 23.12; X_3- Income Above $10,000: 40.42; X_4- Nonwhite Pupil Population: 19.69; X_5- Pupils - Low Income Families: 73.22; X_6- Population Employed: 11.19; X_8- Staff - Without a Degree:

6.17; X_{10}- Teacher Experience: 10.23; X_{11}- Nonwhite Professional Staff: 13.50; X_{12}- Teacher Morale Factor: 11.70; X_{15}- Male Teachers Employed: 7.06; X_{16}- Expenditures - Instructional Salaries: 4.68; and X_{19}- Attendance-Membership Ratio: 48.11. These significant variables were subjected to stepwise discriminant analysis procedures.

Four variables (X_5- Pupils - Low Income Families, X_{18}- Expenditures - Federal Sources, X_8- Staff - Without a Degree, and X_{12}- Teacher Morale Factor) formed the discriminant function for the composite analysis when judged by the F-to-enter criteria. These four variables were analyzed in the order presented, and at step 4 their associated F-to-remove values with 1 and 25 degrees of freedom were: X_5: 120.80; X_{18}: 30.58; X_8: 15.78; and X_{12}: 9.20. These F-to-remove values indicated the relative contribution of each of these four significant variables in the prediction equations.

At step 1, variable 5 entered the discriminant function. The variables not included at this step acquired different F-to-enter values at later steps. Specifically, variable 18 had an F-value of 0.76 and was not significant at step 0; at step 2, however, it had the largest F-to-enter value and was significant at the 0.05 level of confidence. An F-to-enter value change from nonsignificant to significant can be partially explained by the correlation coefficient of these two variables. The first-order correlation coefficient for variable 5 and variable 18 was +0.63. At step 0, variable 5 could be considered a proxy for variable 18. Once variable 5 entered the discriminant function at step 1, variable 18 became the dominant discriminating variable at step 2 with the largest F-to-enter value of 9.00. The moderately direct relationship between variable 5 and variable 18 indicates that in

the urban school district studied the money from federal sources was being spent in those elementary school centers serving pupils from low income families.[4]

An analysis, at step 0, of the differences of the group means related to the variables which entered the composite function shows:

1. Variable 5, Pupils - Low Income Families, had a mean of 26.7 percent for the low productive elementary school center group, or almost ten times the mean percent of 2.8 for the high productive elementary school group.

2. Variable 18, Expenditures - Federal Sources, had a mean of 5.64 percent for the low productive elementary school center group. This is more than one and a half times the mean percent of 3.31 for the high productive elementary school group.

3. Variable 8, Staff - Without a Degree, had a mean of 6.5 percent for the low productive group. This represents three times the mean percent of 2.1 for the high productive group.

4. Variable 12, Teacher Morale Factor, in the low productive group had a mean rating score of 4.58, or approximately one and a half times the mean rating score of 5.34 for the high productive group.[5]

From Table 4 it can be seen that a 93.33 percent accurate classification, a

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[4] This relationship would seem to indicate this school district is in compliance with the comparability standards established by the USOE for the administration of Title I of the Elementary and Secondary Education Act.

[5] Teacher Morale Factor here is represented by a five-item factor to which respondents reacted on a seven-point scale. The stated "one and a half times" is based on a statistical transformation of the mean rating scores for each group into $\bar{Z}$ scores and the comparison of the results.

relatively good discrimination between the high and low productive groups, was obtained using only variables 5 and 8. In this four-variable case, 100 percent accurate classification was obtained by step 3. That is, of the 15 elementary school centers in the low productive group, 15 were accurately classified as were the 15 in the high productive group. Variable 12, which entered the discriminant function at step 4, did not improve the percent of accurate classification; however, because it was a significant discriminating variable at the 0.05 level of confidence it was included in the discriminant function.

Applying the r_{tet} correlation coefficient to test the efficiency of discrimination, this four-variable case accounted for 86.49 percent of the variance between the high and low productive elementary school groups at step 1, and by step 3, 100 percent variance.

From the foregoing analysis, certain significant generalizations can be formulated about the elementary school centers located in the urban school district of this study. It seems reasonable to conclude that an elementary school center with (1) a small percentage of pupils from low income families, (2) less of its total expenditures financed from federal sources, (3) a small percentage of staff without a degree, and (4) high teacher morale is predictive of high productivity. Conversely, an elementary school center with (1) a large percentage of pupils from low income families, (2) more of its total expenditures financed from federal sources, (3) a large percentage of staff without a degree, and (4) low teacher morale is predictive of low productivity.

Set I - student predictor variables

Eight student variables, which included socioeconomic and in-school student

characteristics, constituted the Set I problem for analysis. At step 0, F-tests were performed on each of the eight student variables to ascertain significant differences between the high and low productive groups. Five of the eight student variables at step 0 were significant at the 0.05 level of confidence. With 1 and 28 degrees of freedom, their titles, numbers, and F-to-enter values were: X_1- Adjusted Gross Income: 16.47; X_2- Income Below $3,000: 23.12; X_3- Income Above $10,000: 40.42; X_4- Nonwhite Pupil Population: 19.69; and X_5- Pupils - Low Income Families: 73.22.

Two variables (X_5- Pupils - Low Income Families and X_{22}- Pupil - Valence Toward School Factor) formed the discriminant function for the Set I analysis. Analyzed in the order presented, these predictor variables were significantly discriminating with an associated probability of 0.05 or less. The associated F-to-remove values with 1 and 27 degrees of freedom were: X_5: 81.65; and X_{22}: 5.13.

At step 1, variable 5 entered the discriminant function. The variables not included at this step took on different F-to-enter values at later steps. Variable 22 had an F-value of 1.93 at step 0, and at step 2, an F-value of 5.13. The change in the F-to-enter values from nonsignificant to significant can be partially explained by the correlation coefficient of the two variables involved. The first-order correlation coefficient for variable 5 and variable 22 was +0.58. Once variable 5 entered the discriminant function at step 1, variable 22 assumed the dominant discriminating influence at step 2 with the largest F-to-enter value of 5.13.

An analysis at step 0 of the differences of the group means related to this two-variable case shows:

1. Variable 5, Pupils - Low Income Families, had a mean of 2.8 percent for the high productive group, or almost ten times less the mean percent of 26.7 for the low productive group.

2. Variable 22, Pupil - Valence Toward School Factor in the high productive group had a mean percent of affirmative responses of 62.80, or approximately one half times less the mean percent of affirmative responses of 63.60 for the low productive group.[6]

Table 5 shows that an 86.66 percent of accurate classification of the high and low productive centers was obtained at the first step of the discriminant analysis. Using variables 5 and 22, a 93.33 percent accurate classification of the 30 elementary schools was obtained.

In the test of efficiency of discrimination this two-variable case explained 96.04 percent of the variance between the high and low productive groups.

The Pupil - Valence Toward School Factor, variable 22, represented the average percentage of affirmative responses to eight items on a student survey.[7] The respondents were sixth grade pupils attending the elementary school centers in the urban school district studied.

From the foregoing analysis it seems reasonable to conclude for the urban school

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[6] The stated "one half times" is based on a statistical transformation of the mean percent of affirmative responses for each group into $\bar{z}$ scores and the comparison of the results.

[7] The student survey was administered in May of each school year. The Pupil Valence Toward School Factor was based on the following eight items: (1) Do you like school?, (2) Do you read books from a library?, (3) Do you like your school?, (4) Do you get along better outside of school than in school?, (5) Would you like to spend more time at school?, (6) Do you look forward to coming to school each morning?, (7) Do you talk about school at home?, and (8) Do you think your teachers usually expect too much of you?.

district studied that an elementary school center with (1) a small percentage of pupils from low income families, and (2) a slightly lower pupil valence toward school is predictive of high productivity. The converse of these variables is applicable for low productivity.

The relationship between variable 5 and variable 22 permits some speculation that the pupils from low income families in the urban school district studied have a moderately positive valence toward school.

Set II - school related predictor variables

Sixteen school related variables were selected from the 25 school and non-school variables to form the Set II problem for analysis. To ascertain significant differences between the high and low productive groups, F-tests were performed at step 0. Six of the 16 school related variables with 1 and 28 degrees of freedom were significant at the 0.05 level of confidence. Their variable numbers, titles, and F-to-enter values were: X_8- Staff - Without a Degree: 6.17; X_{10}- Teacher Experience: 10.23; X_{11}- Nonwhite Professional Staff: 13.50; X_{12}- Teacher Morale Factor: 11.70; X_{15}- Male Teachers Employed: 7.06; and X_{16}- Expenditures - Instructional Salaries: 4.68. These six variables were further analyzed using stepwise discriminant analysis to determine the maximal mix of school related variables.

Five variables (X_{11}- Nonwhite Professional Staff, X_8- Staff - Without a Degree, X_{10}- Teacher Experience, X_{16}- Expenditures - Instructional Salaries, and X_{15}- Male Teachers Employed) formed the discriminant function. These variables met the F-to-enter criteria and were analyzed in the order presented. At step 5, with 1 and 24 degrees of freedom, the associated F-to-remove values for the five

significant variables were: X_{11}: 7.46; X_8: 25.89; X_{10}: 11.41; X_{16}: 10.04; and X_{15}: 9.26.

At step 1, variable 11 entered the discriminant function. The variables not included at this step took on different F-to-enter values at later steps. However, all of the variables which met the critical value of F and were included in the Set II discriminant function were also significantly discriminating variables at step 0.

An analysis at step 0 of the significant differences of the group means related to those variables in the discriminant function for Set II shows:

1. The mean percent for variable 11, Nonwhite Professional Staff, for the low productive group was 28.3, or four times the mean percent of 7.0 for the high productive group.

2. Variable 8, Staff - Without a Degree, had a mean of 6.5 percent for the low productive group. This is three times the mean percent of 2.1 for the high productive group.

3. Teacher Experience, variable 10, indicates that the low productive group had an average of almost three years less experience than the high productive group. The mean years of experience were 10.0 for the low and 12.8 for the high.

4. Variable 16, Expenditures - Instructional Salaries, shows the low productive group spent 2.3 percent more on salaries of their total school expenditures than did the high productive group. The mean percents for the two groups were 75.3 and 73.0.

5. Variable 15, Male Teachers Employed, indicates that the high productive group had about 5.4 percent more male teachers than the low productive group.

The mean percent for the high productive group was 16.0, and for the low productive group, 10.6 percent.

Table 6 shows that a decrease in the percent of accurate classification occurred from 96.66 percent at step 4 to 90.00 percent at step 5. This decrease in classification seemed to indicate interactions among the variables which were not immediately apparent. The steps beyond the normal cutoff point showed that ultimately perfect classification of the 30 elementary school centers was obtained by step 7.

The test of efficiency of discrimination using the tetrachoric r statistic and squaring its result indicated that this five-variable case accounted for 86.49 percent of the variance between the high and low productive elementary school groups.

These comparisons permit generalizations about the elementary school centers which constitute these two groups. It seems reasonable to conclude that these school related teacher characteristics for the urban school district studied are predictive of elementary school productivity. Specifically, an elementary school center with (1) a small percentage of nonwhite professional staff, (2) a small percentage of staff without a degree, (3) a large percentage of male teachers, (4) a more experienced teaching staff, and (5) less of its expenditures concentrated on instructional salaries is predictive of high productivity. Conversely, an elementary school center with (1) a large percentage of nonwhite professional staff, (2) a large percentage of staff without a degree, (3) a small percentage of male teachers, (4) a less experienced teaching staff, and (5) more of its expenditures

concentrated on instructional salaries is predictive of low productivity.[8]

Set III - nonschool related predictor variables

Nine nonschool related variables constituted the Set III problem for analysis. To determine the significant differences between the high and low productive groups, F-tests were performed at step 0. Seven of the nine nonschool related variables with 1 and 28 degrees of freedom were significant at the 0.05 level of confidence. Their variable numbers, titles, and F-to-enter values were: X_1- Adjusted Gross Income: 16.47; X_2- Income Below $3,000: 23.12; X_3- Income Above $10,000: 40.42; X_4- Nonwhite Pupil Population: 19.69; X_5- Pupils - Low Income Families: 73.22; X_6- Population Employed: 11.19; and X_{19}- Attendance-Membership Ratio: 48.11.

Four variables (X_5- Pupils - Low Income Families, X_{19}- Attendance-Membership Ratio, X_4- Nonwhite Pupil Population and X_{25}- Voters 'For' Tax Levy) formed the discriminant function for the Set III analysis. These variables met the F-to-enter criteria and were analyzed in the order presented. At step 4, with 1 and 25 degrees of freedom, the associated F-to-remove values for the four significant variables were: X_5: 2.66; X_{19}: 8.49; X_4: 19.38; and X_{25}: 7.88. These values approximate the relative contribution of each of these variables in the prediction equations for Set III.

At step 1, variable 5, pupils from low income families, entered the discriminant function. The variables not included at this step assumed different F-to-enter

[8] Several studies cited in Chapter II support this generalization. For example see: Benson, pp. 24-25; Flanagan, p. 23; Kiesling, p. 24; and Thomas, p. 23.

values at later steps. As a case in point, variable 25, Voters 'For' Tax Levy was not statistically significant at either step 0 or step 1. In combination with variables 1, 2, 3, 6 and 23 at step 3, this variable became statistically significant, had the largest F-to-enter value, and therefore, was included in the discriminant function at step 4.

An analysis of the significant differences at step 0 of the group means for the three discriminating variables which were ultimately included in the Set III function reveals:

1. Variable 5, Pupils - Low Income Families, had a mean of 26.7 percent for the low productive group, or approximately ten times the mean percent of 2.8 for the high productive group.

2. Variable 19, Attendance-Membership Ratio,in the high productive group had 3.0 percent more of its students attending classes daily than did the low productive group.

3. Variable 4, Nonwhite Pupil Population, had a mean of 56.86 percent for the low productive group. This is almost eight times the mean percent of 7.15 for the high productive group.

From Table 7, it can be observed that at each analytical step this four-variable case improved the percent of accurate classification of the 30 elementary school centers, and at step 4, 100 percent accurate classification was obtained.

At step 1, variable 5 accounted for 86.49 percent of the variance between the high and low productive groups, and by step 4 all four variables explained 100 percent of the between group variance.

From the preceding analysis, several generalizations may be formed about the

elementary school centers which constitute these high and low productive groups. An elementary school center with (1) a small percentage of pupils from low income families, (2) a high percentage of pupils in daily attendance,[9] (3) a small percentage of nonwhite pupils, and (4) a slight difference in the percentage[10] of voters 'for' a school tax levy is predictive of high productivity. Conversely, these variables are predictive of low productivity.

Set IV - administrative decision making related predictor variables

Eighteen variables were grouped to form the Set IV problem for analysis. Sixteen of these variables were identical to the variables included in the Set II problem for analysis. The two variables added were variable 4, Nonwhite Pupil Population and variable 5, Pupils - Low Income Families. The rationale for the inclusion of these variables was that opportunities existed for school administrators to decisively influence the composition of a school population and the culturally disadvantaged.

Four variables (X_5- Pupils - Low Income Families, X_{18}- Expenditures - Federal Sources, X_8- Staff - Without a Degree, and X_{12}- Teacher Morale Factor) formed the discriminant function for the Set IV analysis. Each variable in this four-variable case met the critical value of F.

The function developed for Set IV was identical to the function formed for the

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[9] Gordon and Doxey's study cited in Chapter II, page 29 supports the related importance of attendance to educational output.

[10] "A slight difference in the percentage" refers to the 0.61 percent difference between 59.67 mean percent for the low group and a 59.06 mean percent for the high group for variable 25 at step 0. Variable 25's F-value at step 0 was a non-significant 0.01; whereas, at step 4 its F-value was 7.88, significant at the 0.05 level.

composite of 25 school and nonschool variables. Table 8 presents data associated with the Set IV analysis and the first eight steps replicate the composite analysis data presented in Table 4. After step 8, the data in Table 8 and 4 differ; however, these differences are not of critical importance to this analysis because the variables analyzed after step 4 were not significantly discriminating.

Set V - administrative nondecision making related predictor variables

Seven nondecision making related variables constituted the Set V problem for analysis. Five of the seven variables at step 0 were significant at the 0.05 level of confidence. With 1 and 28 degrees of freedom their variable numbers, titles, and F-to-enter values were: X_1- Adjusted Gross Income: 16.47; X_2- Income Below $3,000: 23.12; X_3 - Income Above $10,000: 40.42; X_6- Population Employed: 11.19; and X_{19}- Attendance-Membership Ratio: 48.11.

Two variables (X_{19}- Attendance-Membership Ratio and X_3- Income Above $10,000) formed the discriminant function for the Set V analysis. Analyzed in the order presented, these two variables were significantly discriminating ones with an associated probability of 0.05 or less. The associated F-to-remove values with 1 and 27 degrees of freedom were: X_{19}: 12.80; and X_3: 8.78.

At step 1, variable 19, Attendance-Membership Ratio, entered the discriminant function. The variables not included at this step took on different F-to-enter values at later steps. However, the two variables which met the F-to-enter criteria and were included in the Set V discriminant function were also significantly discriminating variables at step 0.

An analysis of significant differences of the group means of these variables

shows that:

1. Variable 19, Attendance-Membership Ratio, in the high productive elementary school group had 3.0 percent more of its students attending classes daily than did the low productive group.

2. Variable 3, Income Above $10,000, had a mean of 24.7 percent for the high productive group. This is almost one and a half times the mean percent of 10.0 for the low productive group.

It can be observed, from Table 9, that 96.66 percent of the 30 elementary school centers were accurately classified by this two-variable case. After step 2, the percent of accurate classification decreased to 93.33 percent; however, this occurred using nonsignificant discriminating variables.

The test of efficiency of discrimination using the tetrachoric r statistic and squaring its result revealed that this two-variable case accounted for 96.04 percent of the variance between the high and low productive groups.

From the foregoing analysis, generalizations may be stated about the elementary school center groups of this study. An elementary school center which has more students attending classes daily and which serves a geographical area where the inhabitants have relatively higher incomes is predictive of high productivity. The opposite of these characteristics predicts low productivity. Another generalization is that there are community related characteristics such as personal income, employment patterns, and population mobility over which school leaders have no control. On the other hand, there are other community related characteristics which offer administrators opportunities to improve the outputs of the schools.

Summary

To recapitulate, the foregoing subsections presented a composite and five functions of various combinations of school and nonschool predictors. Of these, both the composite and the Set III functions produced a maximal mix of predictor variables. Each function accurately predicted high or low productivity 100 percent of the time and explained 100 percent of the variance between groups.

The composite function included variables 5, 8, 12 and 18. If other elementary school centers composing the urban school district of this study were tested, the variables in the composite function would fall into the following order of importance: X_5- Pupils - Low Income Families, X_{18}- Expenditures - Federal Sources, X_8- Staff - Without a Degree, and X_{12}- Teacher Morale Factor. These same significant variables formed the function developed from the Set IV analysis.

The maximal mix of predictor variables which formed the Set III nonschool function were variables 5, 19, 4 and 25. When employing a predictive model to test untested elementary school centers, these significant variables would fall into the following order of importance: X_5- Pupils - Low Income Families, X_{19}- Attendance-Membership Ratio, X_4- Nonwhite Pupil Population, and X_{25}- Voters 'For' Tax Levy.

Three socioeconomic and sociocultural characteristics accounted for most of the variation in productivity between the two groups. The first, variable 5, Pupils - Low Income Families, explained most of the productivity variation in the composite, student, nonschool and administrative decision making functions. Nonwhite Professional Staff, variable 11, accounted for most of the productivity variation in the school function. Finally, variable 19, Attendance-Membership Ratio, explained

most of the variation in productivity in the administrative nondecision making function.

An inspection of all the prediction equations developed revealed that these six functions accurately predicted high or low productivity for the 30 elementary school centers 90 to 100 percent of the time. Conversely, when discrimination is considered as the percentage of elementary school centers misclassified by the analytical procedures, the percentage of misclassification ranged from zero to 10 percent.

If chance alone were applied to these data, 100 percent of the variability between groups would be accounted for by chance. Using any one of the six derived sets of prediction equations, zero to 14 percent of the variability would not be accounted for by chance, but would be attributed to the variables identified in these functions to predict high or low elementary school productivity.

Employing a Productivity Concept

This study was interested in employing appropriate analyses which would produce additional knowledge associated with correlates to school performance so as to enable an urban elementary school administrator to create and operate a more productive school. The foregoing analyses of the results of this investigation indicated that high and low productive elementary school centers are ascertainable and that various combinations of school and nonschool variables predict high or low productivity.

The procedures employed to determine these results present an opportunity to formulate a construct which may prove to be theoretically fruitful for educational decision makers who are interested in selecting sets of measures of inputs to predict

elementary school center productivity.

Discriminant functions composed of two prediction equations were formed in this study. Within these functions the two equations mapped the best combinations of various school and nonschool input variables to predict high or low productive elementary school centers. The high and low productive centers represented a criterion (fixed performance) of educational output in an educational production function.[11] Elementary school educational output was produced by various input combinations of (1) student variables, i.e. socioeconomic, sociocultural and personal background characteristics; (2) school variables, i.e. teacher quality and influence and expenditures; and, (3) nonschool variables, i.e. population mobility and voter patterns. The discriminant function is depicted by the following set of equations:

$$(1)\quad H = K + b_1X_1 + b_2X_2 + \ldots, + b_nX_n$$

$$(2)\quad L = K + b_1X_1 + b_2X_2 + \ldots, + b_nX_n$$

The ensuing paragraphs discuss the general form of these equations including their symbols and application in this study. First, the high (H) and low (L) productivity in these equations delineates elementary school performance in school centers. In this investigation, school productivity as a measure of educational outcomes portrayed a network of interrelated urban characteristics interacting with a network of in-school characteristics. The educational outcome produced represented a measured level of elementary school center productivity using the dichotomously grouped criterion of high and low productive elementary school centers.

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[11] A brief discussion of one concept of an educational production function is presented in Chapter II, p. 32.

Second, the high (H) and the low (L) productivity represented functions of the varying sets of weighted input characteristics. These sets of weighted characteristics $b_1X_1 + b_2X_2 + \ldots, + b_nX_n$, referred to as input variables,were measured in physical, psychological and monetary terms.

Third, what a child brings to school, i.e. his various attitudes, feelings, specific sociocultural aptitudes and skills, affected educational outcomes, or in this instance, elementary school productivity. These subcultural traits varied extensively both between and within groups of children. To account for these differences, a constant (K) was established. This constant (K) served to maximize the between-group differences relative to the within-group differences in the identified high and low elementary school center groups.

One aspect of this construct represented a unique approach in determining elementary school productivity. Using a single criterion, such as achievement test scores or school holding power, against which input variables are tested has often resulted in inadequately measuring the impact of numerous input variables upon school performance. School productivity in this study was determined by using a dichotomous criterion of high and low productivity to predict which variables would best explain the productive quality of an elementary school center. This dichotomous criterion, or gradient of productivity, represents a fixed performance range of expected elementary school productivity.

The value of this approach occurs when various sets of predictor variables of high productivity and various sets of predictor variables of low productivity which are measured in physical, psychological and monetary terms become alternative inputs to be examined by educational decision makers. When placed in an order of

preference, these alternatives could ultimately serve as a plan of action for school administrators.

In more precise terms, the construct or productivity concept used in this investigation was depicted by two prediction equations:

$$(1)\quad H = K + b_1X_1 + b_2X_2 + \ldots, + b_nX_n$$

$$(2)\quad L = L + b_1X_1 + b_2X_2 + \ldots, + b_nX_n$$

Equation (1) represented a prediction of high productivity, and equation (2) represented a prediction of low productivity.

H is a fixed performance criterion. In this investigation high productivity was a group of elementary school centers in an urban school district whose actual school median composite achievement score was located at least three-fourths of a standard error of estimate above a regression line predicting average productivity (school achievement) from a given level of current expenditures per pupil (ADM).

L is a fixed dichotomy to the performance criterion. In this investigation, low productivity was a group of elementary school centers in an urban school district whose actual school median composite achievement score was located at least three-fourths of a standard error of estimate below the regression line of average productivity.

K represents a specific constant established by the discriminant analysis to allow for the maximal differences in group means, relative to the distribution of scores in each group.

The equation symbols $b_1X_1 + b_2X_2 + \ldots, + b_nX_n$ represent sets of weighted measures ($b_1, b_2, \ldots, b_n$), and student, school and nonschool related variables ($X_1, X_2, \ldots, X_n$). This part of the equation functions in a complex and obscure

manner. To predict high or low productivity, raw score measures were developed for the identified high and low productive elementary school centers. Elementary school centers were organized by group membership, and input variable data were analyzed using stepwise discriminant analysis to produce discriminant functions.

Within these functions significant variable predictors were observed in prediction equations and these equations, in turn, identified various combinations of input variables to predict elementary school center productivity in an urban school district. Both the efficiency, and the accuracy of discrimination in the amount of variance explained and in the percent of accurate classification obtained, were indicative of the high direct relationship between the predicted results and the observed results.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS FOR FURTHER STUDY

Summary

The primary problem of this study was to identify those school and nonschool variables which would differentiate between high and low productivity in elementary school centers confined to an urban school district. More specifically the study was purposively directed to (1) the identification of high and low productive elementary school centers by measuring the relationship between current expenditures per pupil and standardized composite achievement test scores, and (2) the determination of school and nonschool variables which would predict high or low productive elementary school centers.

The problem was investigated in two phases. Simple regression analysis to identify a dichotomous criterion of elementary school center productivity was used in phase one. Average productivity represented the measured relationship between expenditures and achievement. The high and low productive groups consisted of school centers with school achievement scores located at least three-fourths of a standard error of estimate above or below a regression line of average productivity.

Stepwise discriminant analysis was employed in phase two to find a function for each of several combinations of school and nonschool variables which would

predict high or low productivity. A composite of 25 school and nonschool independent predictor variables was analyzed, as were five combinations of these variables. The five combinations included: (1) one function which used student related variables, (2) two functions, one of which focused on school while the other on all nonschool related variables; and (3) two functions derived from categorizing the 25 school and nonschool variables into administrative decision making and administrative nondecision making related variables. In predicting high or low productivity, the discriminating equations classified the identified elementary school centers into one of the two productivity groups. Within each set of equations a maximal mix of predictor variables was observed. To test the efficacy of these prediction equations, both the percent of accurately classified elementary school centers and the efficiency of discrimination, or amount of variance explained by the variables included in these discriminant functions, were calculated.

Elementary school centers which served grades one through six and had administered the district wide achievement tests to fourth grade pupils during the 1969-1970 school year constituted the sample in phase one from which the dichotomous criterion variable was identified. The independent variable data of phase two were obtained from the urban school district's central office records, and from the records of the U. S. Office of Education and the U. S. Bureau of Internal Revenue.

Findings

The major findings in phase one of this investigation were:

1. The regression line, or line of average productivity, relating elementary

school center achievement to per pupil expenditures was significant at the 0.01 level of confidence. On the basis of this statistically significant variation, 15 elementary school centers were designated as being high productive and 15 elementary school centers were designated as being low productive.

In phase two, 25 variables were organized for analyses into problem sets. The significantly discriminating variables observed in various discriminant functions were as follows:

1. Four variables constituted the maximal mix of discriminating variables for the composite function. Presented in their order of contribution in the function, these variables were: X_5- Pupils - Low Income Families, X_{18}- Expenditures - Federal Sources, X_8- Staff - Without a Degree, and X_{12}- Teacher Morale Factor. This four-variable case accounted for 100 percent variance between the productivity groups and perfectly classified all 30 elementary school centers. Twenty-one predictor variables in this problem set were found to be nonsignificant.

2. Variable 5, Pupils - Low Income Families and variable 22, Pupil - Valence Toward School Factor were the significantly discriminating variables which formed the student discriminant function. This two-variable case classified 93.33 percent of the elementary school centers and accounted for 96.04 percent of the variance between groups.

3. Five variables, descriptive of teacher characteristics, constituted the maximal mix of predictor variables for the school discriminant function. They were X_{11}- Nonwhite Professional Staff, X_8- Staff - Without a Degree, X_{10}- Teacher Experience, X_{16}- Expenditures - Instructional Salaries, and X_{15}- Male Teachers

Employed. This five-variable case accurately classified 90 percent of the elementary school centers and explained 86.49 percent of the variance between groups. Variable 15, Male Teachers Employed, was a significant predictor in the function; however, its presence contributed to a decrease in the percent of accurate classification from 96.66 percent to 90 percent.

4. In the nonschool related problem set of nine variables, four variables produced the maximal mix of predictors of productivity. They were X_5- Pupils - Low Income Families, X_{19}- Attendance-Membership Ratio, X_4- Nonwhite Pupil Population, and X_{25}- Voters 'For' Tax Levy, which collectively classified 100 percent of the elementary school centers and accounted for 100 percent of the variability in elementary school center productivity.

5. The discriminant function developed for the 18 decision making related predictor variables was identical to the composite function derived from an analysis of the 25 school and nonschool variables.

6. In the nondecision making problem set of seven variables, Attendance-Membership Ratio, variable 19, and Income Above $10,000, variable 3 were the significant variables. This two-variable case classified accurately 96.66 percent of the elementary school centers and explained 96.04 percent of the variance between the productivity groups.

Conclusions

This investigation was an exploratory field study which followed an ex post facto design; therefore, the conclusions are limited to the elementary school centers in the urban school district studied.

The following conclusions appear justified:

1. High and low productive elementary school centers are ascertainable using simple regression analysis to measure the relationship of school achievement to per pupil current expenditures.

2. For the composite function of school and nonschool variables and the administrative decision making function, the predictors related to student socio-economic and teacher preparation characteristics tended to be the maximal discriminating variables of school productivity. The findings of the study suggest that varying percentages of pupils from low income families enrolled in school and certificated staff without a degree may explain most of the variability in elementary school center productivity.

3. For the school related function, the predictors related to staff sociocultural characteristics and teacher preparation and experience tended to be the maximal discriminating variables of school productivity. The results of this study suggest that varying percentages of nonwhite professional staff, certificated staff without a degree and differences in the number of years of teaching experience may account for most of the variability in elementary school center productivity.

4. For the nonschool related function, the predictors related to pupil socio-economic and sociocultural traits, to pupil attendance, and to voter patterns associated with passing a school tax levy tended to be the maximal discriminating variables of school productivity. The results of this study suggest that varying enrollment percentages of pupils from low income families as well as nonwhite pupils together with differing levels of average daily attendance by students explain most of the variability in elementary school productivity.

5. For the administrative nondecision making related function, the predictors related to pupil attendance and the income level of the residents of a geographical area served by an elementary school center tended to be the maximal discriminating variables of school productivity. The findings of this study suggest that differing levels of average daily attendance by students and varying percentages of income above $10,000 may explain most of the variability in elementary school center productivity.

6. The input-output analytical procedures employed in this study were generally definitive in identifying input variables which were predictive of high and low productivity. This conclusion is based upon the demonstrated ability of the identified variables in the prediction equations to classify elementary school centers at high percentage levels and to efficiently discriminate at high percentage levels, thereby explaining most of the variance between productivity groups.

The foregoing summary of findings and conclusions should be prudently and judiciously interpretated by the educational decision maker. While the procedures employed in this study offer an opportunity to apply a productivity concept which may prove helpful, it should not be concluded that the application of these findings will, without limits, result in improved productivity. It is particularly important that the educational decision maker keep in mind that this study was not designed to deal with such essential but little known aspects of education as: (1) the process variables, those human actions which transform the raw materials of inputs into opportunities for learning, (2) how children learn cognitively and affectively, and (3) the advantages associated with a sociopsychological climate that is favorable to learning in the classroom and the school. Finally, it is important to note that

research results cannot be substituted for policy, but can be one of several inputs to policy formulation.

Recommendations for Further Study

1. It is recommended that in the identification of high and low productive school centers the measured relationship of achievement and background variables including information about income, parental education and occupational status as well as expenditures be analyzed. This would have the effect of identifying a criterion variable of high and low productivity which is based upon the interaction of school and environmental effects rather than upon school effects alone.

2. Further studies should be conducted to ascertain whether the significant predictors presented in this study would also be significant in studies conducted in other urban school districts located in different sections of the country.

3. Longitudinal studies should be made to further examine the significant factors in this study. Results based on a cross sectional study made at a given point in time hold inherent limitations especially when used to guide policy making for the future. Predictors which are statistically and educationally significant at one point in time may not be the paramount predictor variables of output in the future, especially if other important variables are subject to change.

4. A factor analysis of the numerous independent input variables related to educational outcomes should be considered in future studies. This would have the effect of reducing input variables in an empirically meaningful way into indexes or sets of indexes.

5. Further studies should be conducted which are directed at individual

classrooms within the elementary schools of one or several urban school districts. The input and output variables employed would represent the aggregate values of these elementary classrooms. Heuristically, these studies would have the effect of determining predictors of high or low classroom productivity and could ultimately lead to possibilities for comparisons among classrooms, schools, and districts.

6. Further studies are needed to investigate measures of input, of output, and of process variables. Serious attempts have been made to find and to use the best measures available. Nevertheless, in terms of the concept of productivity these measures will not continue to always prove to be sufficient unless data collection techniques receive the closest of controls and unless the development of measures of variables within a conceptual productivity framework are undertaken.

APPENDIX

Table 11

BASIC DATA RELATIVE TO SCHOOL AND NONSCHOOL INDEPENDENT VARIABLES FOR THE HIGH PRODUCTIVE ELEMENTARY SCHOOL CENTERS

Elementary School Center	Variable Number 1	2	3	4	5	6	7	8
ESC_{08}	19618.	.240	.232	.000	.000	.343	8664.	.000
ESC_{09}	53930.	.328	.173	.335	.070	.411	9145.	.000
ESC_{10}	20089.	.252	.315	.279	.000	.334	9425.	.040
ESC_{15}	14619.	.230	.335	.000	.000	.394	7970.	.080
ESC_{25}	21766.	.257	.318	.139	.020	.343	9836.	.000
ESC_{27}	22526.	.257	.318	.000	.010	.420	9141.	.000
ESC_{31}	18130.	.282	.244	.009	.010	.367	8637.	.000
ESC_{34}	19345.	.235	.265	.002	.030	.349	9512.	.000
ESC_{36}	11714.	.365	.164	.009	.170	.357	13396.	.200
ESC_{37}	17101.	.411	.088	.010	.030	.337	9792.	.000
ESC_{38}	17301.	.229	.335	.003	.050	.371	8939.	.000
ESC_{44}	19650.	.305	.172	.219	.000	.352	9691.	.000
ESC_{45}	21194.	.253	.272	.054	.010	.383	9952.	.000
ESC_{51}	19559.	.282	.244	.014	.000	.384	10232.	.000
ESC_{64}	18870.	.241	.232	.000	.020	.370	9881.	.000

Table 11 Continued

Elementary School Center	Variable Number							
	9	10	11	12	13	14	15	16
ESC_{08}	.270	13.1	.040	5.60	.307	35.1	.077	.7419
ESC_{09}	.230	7.8	.120	4.77	.325	23.5	.930	.7013
ESC_{10}	.360	13.5	.140	5.22	.214	29.5	.071	.7540
ESC_{15}	.230	12.6	.080	6.04	.153	33.1	.077	.6626
ESC_{25}	.390	12.1	.070	5.52	.142	32.6	.107	.7912
ESC_{27}	.340	12.1	.030	5.20	.250	32.2	.125	.7515
ESC_{31}	.520	12.9	.040	5.59	.240	29.6	.160	.7283
ESC_{34}	.330	9.5	.000	5.33	.222	33.3	.111	.7288
ESC_{36}	.200	17.1	.000	4.80	.200	17.9	.000	.6954
ESC_{37}	.330	12.5	.110	6.21	.111	29.8	.111	.7118
ESC_{38}	.180	9.1	.050	5.66	.363	31.5	.136	.7039
ESC_{44}	.350	12.2	.080	5.04	.115	34.3	.077	.7810
ESC_{45}	.400	18.0	.090	4.83	.285	32.7	.086	.7547
ESC_{51}	.380	15.7	.130	5.40	.125	26.0	.250	.6919
ESC_{64}	.460	13.9	.080	4.86	.153	34.9	.115	.7522

Table 11 Continued

Elementary School Center	Variable Number								
	17	18	19	20	21	22	23	24	25
ESC_{08}	.011	.0000	.939	.084	.694	.619	.066	43.	.382
ESC_{09}	.017	.0846	.939	.116	.712	.619	-.046	63.	.710
ESC_{10}	.012	.0031	.946	.091	.676	.579	-.032	66.	.615
ESC_{15}	.010	.0007	.942	.122	.747	.621	.026	10.	.612
ESC_{25}	.011	.0462	.937	.054	.667	.624	-.013	68.	.674
ESC_{27}	.012	.0023	.954	.087	.675	.642	-.036	46.	.687
ESC_{31}	.014	.0024	.934	.085	.629	.611	-.134	15.	.672
ESC_{34}	.014	.0003	.946	.070	.654	.628	.029	12.	.454
ESC_{36}	.023	.3406	.931	.072	.740	.636	-.144	75.	.559
ESC_{37}	.009	.0015	.949	.108	.735	.638	.042	14.	.502
ESC_{38}	.014	.0000	.937	.068	.716	.650	.022	36.	.540
ESC_{44}	.011	.0000	.952	.070	.721	.627	-.005	3.	.581
ESC_{45}	.012	.0078	.934	.075	.709	.609	-.114	60.	.615
ESC_{51}	.010	.0005	.928	.072	.592	.612	-.132	19.	.730
ESC_{64}	.013	.0069	.939	.047	.642	.586	.003	60.	.526

Table 12

BASIC DATA RELATIVE TO SCHOOL AND NONSCHOOL INDEPENDENT VARIABLES FOR THE LOW PRODUCTIVITY ELEMENTARY SCHOOL CENTERS

Elementary School Center	Variable Number							
	1	2	3	4	5	6	7	8
ESC_{07}	7825.	.311	.101	.019	.140	.331	9525.	.140
ESC_{13}	15070.	.368	.185	.945	.390	.306	9223.	.000
ESC_{17}	3533.	.372	.092	1.000	.130	.368	8700.	.090
ESC_{24}	3615.	.372	.083	.995	.270	.359	9863.	.070
ESC_{32}	14484.	.268	.196	.784	.100	.338	8639.	.080
ESC_{33}	25637.	.310	.190	.002	.200	.289	9656.	.050
ESC_{40}	5951.	.385	.051	.405	.270	.277	8899.	.130
ESC_{42}	15711.	.334	.089	.001	.210	.269	9467.	.030
ESC_{48}	10721.	.378	.126	.999	.280	.366	9019.	.030
ESC_{50}	4341.	.450	.036	.125	.240	.338	8901.	.110
ESC_{55}	7012.	.387	.064	.818	.270	.299	9059.	.030
ESC_{58}	7513.	.388	.064	.966	.400	.328	10541.	.020
ESC_{61}	6035.	.385	.051	.228	.340	.339	9809.	.100
ESC_{67}	4896.	.367	.091	.305	.360	.319	9625.	.040
ESC_{68}	5083.	.367	.091	.937	.400	.197	8712.	.060

Table 12 Continued

Elementary School Center	Variable Number 9	10	11	12	13	14	15	16
ESC_{07}	.450	11.7	.090	5.67	.409	29.9	.136	.7793
ESC_{13}	.305	8.3	.570	4.66	.173	30.8	.174	.7674
ESC_{17}	.250	8.6	.440	4.66	.375	28.5	.156	.7438
ESC_{24}	.260	11.5	.580	3.50	.348	28.2	.163	.7729
ESC_{32}	.260	9.4	.210	4.06	.263	29.9	.158	.7311
ESC_{33}	.300	14.2	.050	4.02	.100	31.3	.150	.7620
ESC_{40}	.305	13.1	.090	3.57	.304	29.3	.217	.7608
ESC_{42}	.310	8.8	.130	4.37	.312	27.6	.125	.7270
ESC_{48}	.250	9.2	.650	4.85	.175	28.4	.100	.7690
ESC_{50}	.390	10.1	.060	5.57	.055	28.2	.278	.7196
ESC_{55}	.340	10.9	.540	3.39	.314	28.8	.200	.7135
ESC_{58}	.180	8.2	.280	4.78	.200	28.3	.200	.7652
ESC_{61}	.350	9.9	.140	4.97	.172	27.0	.207	.7590
ESC_{67}	.220	9.2	.070	5.34	.222	29.8	.037	.7719
ESC_{68}	.210	7.4	.340	5.23	.234	30.2	.106	.7536

Table 12 Continued

Elementary School Center	Variable Number 17	18	19	20	21	22	23	24	25
ESC_{07}	.012	.0201	.913	.109	.721	.604	.011	83.	.396
ESC_{13}	.018	.0738	.903	.076	.731	.659	-.064	97.	.754
ESC_{17}	.016	.0156	.930	.111	.738	.593	-.065	63.	.710
ESC_{24}	.013	.0716	.917	.060	.705	.667	-.176	47.	.748
ESC_{32}	.013	.0268	.928	.095	.665	.605	-.022	68.	.470
ESC_{33}	.012	.0172	.919	.071	.670	.665	-.042	93.	.477
ESC_{40}	.014	.0627	.892	.110	.692	.590	.005	15.	.552
ESC_{42}	.010	.0209	.887	.108	.622	.573	.213	39.	.466
ESC_{48}	.013	.0443	.924	.076	.781	.695	-.101	14.	.732
ESC_{50}	.010	.0223	.896	.101	.727	.588	-.151	44.	.285
ESC_{55}	.012	.0544	.917	.151	.716	.649	-.135	58.	.619
ESC_{58}	.019	.2327	.904	.059	.717	.657	-.158	77.	.682
ESC_{61}	.014	.0735	.883	.130	.671	.639	-.036	100.	.574
ESC_{67}	.013	.0581	.904	.118	.680	.666	-.043	81.	.545
ESC_{68}	.016	.0522	.928	.050	.750	.690	-.073	7.	.941

Table 13

MEANS AND STANDARD DEVIATIONS FOR SCHOOL AND NONSCHOOL VARIABLES

No.	Variable Title	High Productive Elementary School Center Group		Low Productive Elementary School Center Group		High and Low Productive Elementary School Center Group	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1.	Adjusted Gross Income	21,027.46	9,506.79	9,161.80	6,151.21	15,094.63	9,748.44
2.	Income Below $3,000	27.78	5.35	36.28	4.27	32.03	6.32
3.	Income Above $10,000	24.71	7.31	10.00	5.18	17.36	9.57
4.	Nonwhite Pupil Population	7.15	11.46	56.86	41.85	32.00	38.68
5.	Pupils - Low Income Families	2.80	4.43	26.67	9.85	14.73	14.03
6.	Population Employed	36.77	2.65	32.02	4.82	34.39	4.44
7.	Teachers' Salary	9,614.20	1,208.98	9,309.20	536.61	9,461.70	916.32
8.	Staff - Without a Degree	2.13	5.42	6.53	4.21	4.33	5.18
9.	Staff - Master's Degree	33.13	9.58	29.20	7.12	31.17	8.39
10.	Teacher Experience	12.81	2.76	10.03	1.91	11.42	2.68
11.	Nonwhite Professional Staff	7.07	4.38	28.27	21.91	17.67	18.59
12.	Teacher Morale Factor	5.34	0.44	4.58	0.74	4.96	0.70
13.	Staff Change	21.37	8.08	24.37	10.09	22.87	8.96
14.	Pupil-Teacher Ratio	30.41	4.73	29.08	1.21	29.74	3.40
15.	Male Teachers Employed	10.64	5.39	16.05	5.75	13.34	6.02
16.	Expenditures - Instructional Salaries	73.00	3.55	75.30	2.10	74.16	3.05
17.	Expenditures - Supplies, Books, Materials	1.29	0.35	1.37	0.26	1.33	0.30
18.	Expenditures - Federal Source	3.31	8.82	5.64	5.34	4.48	7.14
19.	Attendance-Membership Ratio	94.05	0.76	90.97	1.54	92.51	1.94
20.	Pupil - Psychological Referrals	8.14	2.12	9.50	2.88	8.82	2.54
21.	Pupil - Academic Confidence	68.73	4.48	70.57	3.99	69.65	4.20
22.	Pupil - Valence Toward School	62.00	1.93	63.60	4.01	62.80	3.14

Table 13 Continued

No.	Variable Title	High Productive Elementary School Center Group		Low Productive Elementary School Center Group		High and Low Productive Elementary School Center Group	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
23.	Pupil Change	-3.12	6.93	-5.58	9.45	-4.35	8.10
24.	Age - School Facilities	39.33	25.16	59.07	30.70	49.20	28.86
25.	Voters 'For' Tax Levy	59.06	9.86	59.67	16.80	59.37	13.31

Table 14

INTERCORRELATION MATRIX OF ALL VARIABLES

Correlation Matrix Variable No.	1	2	3	4	5	6	7	8	9	10
1	1.000	-0.120	0.127	-0.008	-0.096	0.156	-0.154	-0.347	-0.072	-0.266
2		1.000	-0.819	0.122	0.463	-0.003	0.385	0.190	-0.076	0.013
3			1.000	0.035	-0.254	0.185	-0.355	-0.208	-0.036	-0.040
4				1.000	0.247	0.212	-0.080	-0.265	-0.375	-0.335
5					1.000	-0.141	0.430	-0.033	-0.393	-0.171
6						1.000	-0.041	-0.054	0.015	-0.072
7							1.000	0.422	-0.124	0.430
8								1.000	-0.090	0.422
9									1.000	0.358
10										1.000

Variable	11	12	13	14	15	16	17	18	19	20
1	-0.023	-0.273	0.065	-0.116	-0.026	-0.009	0.057	-0.081	0.042	0.083
2	0.132	0.104	-0.319	-0.544	0.109	-0.180	0.213	0.424	-0.191	0.188
3	0.064	-0.029	0.074	0.411	-0.055	0.122	-0.104	-0.314	0.217	-0.244
4	0.831	-0.271	0.139	-0.051	-0.088	0.104	0.399	0.201	0.513	-0.263
5	0.156	0.059	-0.234	-0.320	-0.182	0.024	0.590	0.630	-0.316	-0.230
6	0.329	-0.028	0.070	-0.108	0.193	-0.052	0.122	0.022	0.010	0.150
7	-0.096	-0.213	-0.165	-0.619	-0.219	0.086	0.524	0.800	-0.283	-0.270
8	-0.348	0.022	0.070	-0.514	-0.180	-0.278	0.305	0.467	-0.154	0.192
9	-0.161	0.046	-0.148	0.257	0.419	0.313	-0.432	-0.431	-0.200	0.069
10	-0.180	-0.312	-0.148	-0.113	0.045	0.086	-0.128	0.135	-0.199	-0.044
11	1.000	-0.258	0.115	-0.027	-0.025	0.027	0.149	0.016	0.416	-0.157
12		1.000	-0.251	0.149	-0.034	-0.040	-0.207	-0.194	-0.047	0.063

Table 14 Continued

Variable No.	11	12	13	14	15	16	17	18	19	20
13			1.000	-0.054	-0.188	-0.030	0.179	-0.044	0.116	0.205
14				1.000	0.039	0.447	-0.536	-0.692	0.293	-0.185
15					1.000	-0.221	-0.263	-0.259	-0.308	0.037
16						1.000	-0.042	-0.109	0.144	-0.470
17							1.000	0.802	-0.037	-0.260
18								1.000	-0.240	-0.170
19									1.000	-0.184
20										1.000

Variable No.	21	22	23	24	25
1	-0.138	-0.001	0.163	0.274	0.059
2	0.380	0.139	-0.357	-0.139	0.095
3	-0.176	0.086	0.107	0.209	0.120
4	0.415	0.371	-0.444	-0.140	0.717
5	0.269	0.580	-0.317	0.093	0.418
6	0.126	0.011	-0.321	0.325	0.058
7	-0.007	0.134	-0.315	0.410	-0.017
8	0.240	-0.267	-0.119	0.104	-0.258
9	-0.461	-0.461	-0.034	0.053	-0.237
10	-0.154	-0.189	-0.272	0.176	-0.201
11	0.384	0.396	-0.366	-0.162	0.650
12	0.212	0.080	0.167	-0.098	-0.168
13	0.031	-0.171	0.177	0.046	0.067

Variable No.	21	22	23	24	25
14	-0.068	0.007	0.365	-0.177	-0.160
15	-0.378	-0.292	-0.253	-0.149	-0.066
16	-0.064	0.128	0.012	0.219	0.119
17	0.279	0.259	-0.380	0.332	0.362
18	0.259	0.235	-0.400	0.335	0.163
19	0.393	0.338	-0.110	-0.210	0.276
20	0.036	-0.327	0.226	0.044	-0.290
21	1.000	0.412	-0.205	-0.139	0.181
22		1.000	-0.337	-0.078	0.491
23			1.000	-0.111	-0.414
24				1.000	-0.147
25					1.000

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BIOGRAPHICAL SKETCH

Carl J. Daeufer was born June 9, 1931, in Allentown, Pennsylvania. In June, 1949, he was graduated from Allentown High School. He received the degree of Bachelor of Science from State Teachers College, Kutztown, Pennsylvania, in June 1953, with a major in both elementary and secondary teaching. From 1953 to 1956 he taught elementary school. He received a Master of Education degree from Temple University, Philadelphia, Pennsylvania in February, 1955. In 1956, he worked in the Overseas Dependent School System as a teacher on Okinawa, and from 1957 to 1960 he served as a school administrator of an elementary, a junior high and a senior high school. Beginning in 1960 he worked at the University of Hawaii in the College of Education with secondary student teachers, engaged in demonstration teaching and taught undergraduate college courses. He was promoted to Assistant Professor in 1963 and taught graduate level courses in the areas of secondary education and reading methodology. From 1964 to 1970 he was a staff member in the Department of Education, Trust Territory of the Pacific Islands through a contract with the Territory and the College of Education, University of Hawaii. In this capacity he served as Coordinator of Secondary Education, Co-ordinator of Teacher Education and Coordinator of Elementary Education.

In 1970, he enrolled in the Graduate School of the University of Florida and since that date has been working toward the Doctor of Education degree with a

major in educational administration with emphasis on general administration.

Carl J. Daeufer is married to the former Alice Sumie Yoshimori and is the father of one daughter, Sumy Carel. He is a member of Kappa Delta Pi and Phi Delta Kappa.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

Kern Alexander, Jr., Chairman
Professor of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

Ralph B. Kimbrough
Professor of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

Richard H. Hiers
Associate Professor of Religion

This dissertation was submitted to the Dean of the College of Education and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Education.

August, 1972

Dean, College of Education

Dean, Graduate School